

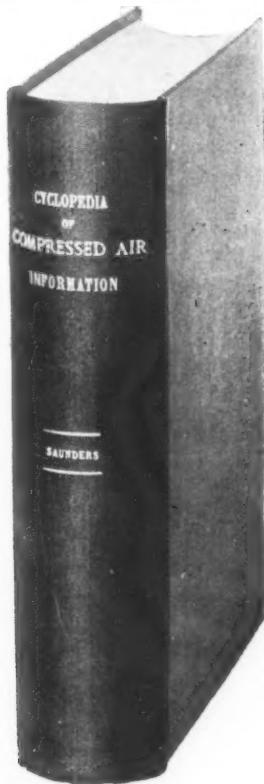
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A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF
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VOL. VII.

NEW YORK, SEPTEMBER, 1902.

No. 7.



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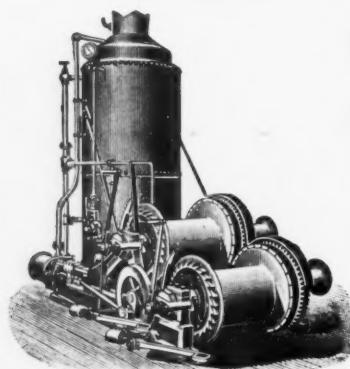
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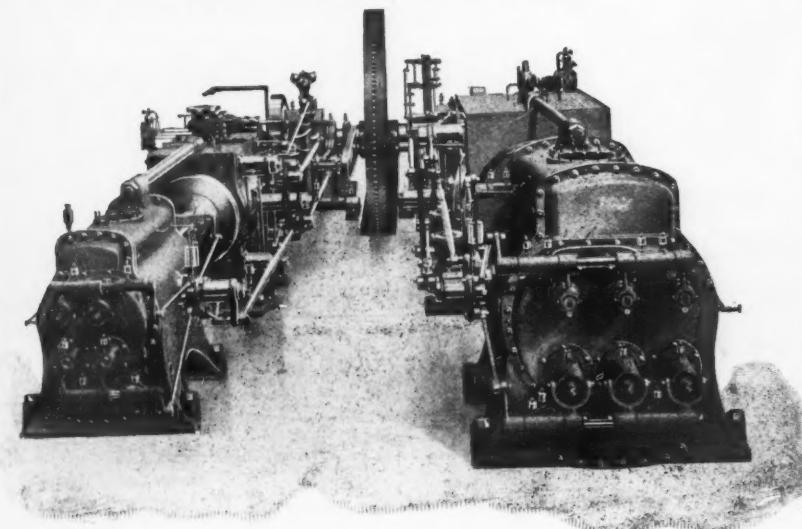
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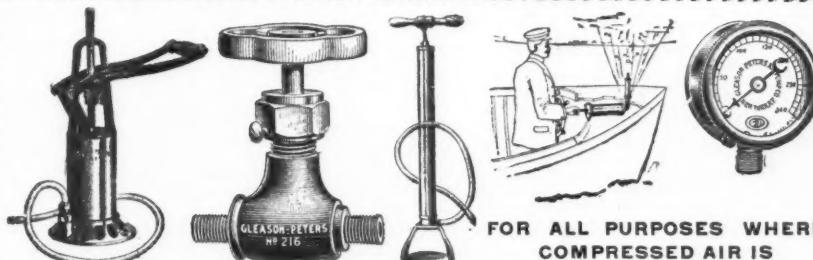
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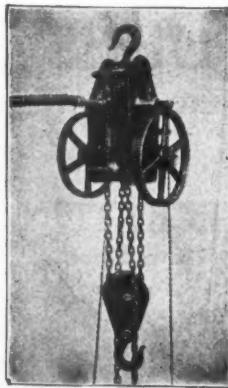
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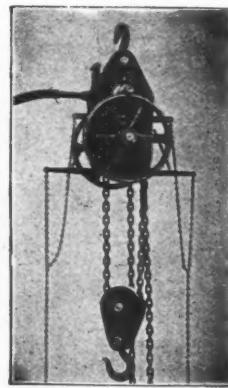
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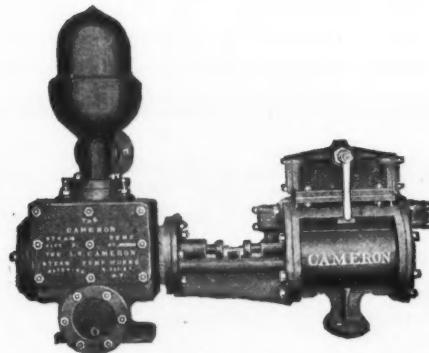
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Abuse in the Use of Compressed Air.

It is interesting to note the correspondence and comment which has recently taken place in some of the English mining papers in relation to an alleged disease contracted by men working in the South African mines. It is reported that Cornish drill men went to South Africa to earn higher wages than they could receive at home and that in a short time they were compelled to return home because of a disease of the lungs which proved fatal in some two years' time. The *Royal Cornwall Gazette* asks the question whether or not, under such circumstances, it is not better for men to work in the Cornish mines under healthier conditions and at less wages. It seems very likely that because of the feeling indicated by the remark of the *Gazette* this disease and its effects may have been exaggerated in the popular mind, yet there are reasons for believing that a form of

consumption may be contracted in mine and tunnel headings by continuous work under certain circumstances, and a discussion of the subject with suggested precautions may not be out of place. It is reported that a Captain Oates, "well-known in mining circles at home and at the Cape," has been "very forcibly struck" with the belief that it is a serious matter, and he has ordered medical men in the mining district to prepare and tabulate statistics of the deaths among the miners during the past two years. Mr. Nicholas Trestail, Civil Engineer, of Redruth, has also taken much interest in the matter, and in a recent letter to the press he says:

"Although, no doubt, inhaling fine dust causes most of the mischief that produces phthisis, I am sure there is another thing, too, that does not conduce to the health of the miner. It is generally supposed that exhaust air from rock drills is beneficial to the miner, and probably it is up to a certain point, but these machines are invariably working a long way off from any natural ventilation, and if air was compressed and sent down in a pure state, much better conditions would exist, but there is no doubt that air compressed with lubricants generally used for the compressor cylinders is most objectionable. In all well laid out underground air mains a reservoir is fixed to catch the moisture, and, if properly attended to, would partially prevent some of the mischief, but there is no disguising the fact that air compressed to 80 lbs. per square inch (the pressure mostly used for rock drill work) when mixed with ordinary oils becomes very offensive, indeed. About two years ago I consulted a well-known chemist with a view of experimenting on the purity of air so compressed, but the costs for carrying out such experiments thoroughly was rather more than an individual could be expected to incur, but I am quite satisfied it would repay any company using a num-

ber of rock drills, or those using compressed air for ventilating purposes, to test the matter. I am strongly of opinion that much mischief is caused to the health of miners by the use of inferior oils for lubricating compressor cylinders, and I would suggest glycerine as a substitute in all cases."

This is a very striking and important statement because it calls attention to what might be called the abuse of compressed air, and it is well worth sounding an alarm so that by the use of proper remedies these dangers may be avoided. In the first place, as to dust: It is said that the usual water pipe leading in the mine is not a part of the South African installation, hence the miners at work are at all times subject to an atmosphere of fine dust which gets in the lungs and produces consumption. The mines in South Africa are very extensive and use a large number of rock drills. It is also well known that they are dry mines; that is, they bear very little water, hence it is to be inferred that the drilling operations are conducted dry, but in view of our large experience elsewhere in mines of all kinds, many of them quite as dry as the African mines, it is rather strange to note that no such trouble as that referred to has been incurred, at least so far as we know. It is quite possible, however, that ill effects may have been produced in a number of cases and that the cause has not been properly investigated, and, through neglect or otherwise, the matter has never attracted attention. That an atmosphere impregnated with fine grit particles will produce consumption is well known. The disease is commonly called "stone consumption," and its development was at one time quite marked in the Ohio Sandstone Quarries, particularly where grindstones were produced. About twenty-five years ago workmen engaged in turning grindstones contracted a disease

of the lungs which usually proved fatal in about seven years' of service. The lungs of the deceased were impregnated with small triangular particles of sand rock and it was only the temptation of high wages which would induce a man to learn the trade in a grindstone mill. Later on improvements were introduced and safety drafts applied, by means of which the dust was carried away and the operator maintained in a clearer atmosphere, so that this disease no longer affects the men. It is quite possible to understand a similar accumulation of stone particle in the lungs of miners produced by working in an atmosphere of dust produced by drilling without water, and the first and most obvious remedy to suggest is to put water in the holes. This not only will prevent a discharge of dry dust, but it assists the drilling operations. If water is not available in large quantities, it should be used in small quantities, especially in places where it is found that the dust is liable to accumulate. The use of compressed air exhausting from a power drill should very materially assist in driving this dust from the working places in a mine. If there is not sufficient air from the exhaust of the machines a separate hose connection should be provided by means of which at intervals a blast of compressed air might be discharged at places where dust is found to accumulate in the atmosphere. Those accustomed to work in headings know very well that the exhaust from machine drills produce a very perceptible cooling effect in the heading, and that, in addition to this, the atmosphere there is usually clear. This is particularly noticeable shortly after a blast and where smoke and other products of combustion have accumulated. As the power drills are started it is found that a piston of clearer air gradually accumulates in the heading and forces the smoke to the rear.

As to the objectionable nature of the compressed air discharged due to its being impregnated with bad oils, this is a matter which may be easily remedied. The first and most logical remedy is to use compound air compressors; that is, compressors which even at 80 pounds working pressure compress in two or more stages with intercoolers in between. By this process of compound compression greater economy is affected in steam consumption and a purer, cooler and drier air is produced. The oil which is sometimes carried over with the air is an oil vapor produced by high air temperatures and it is deposited along the line all the way from the engine room to the working, just in proportion to the changes in temperatures which the air undergoes; hence we have an air conduit of considerable length with the interior of the pipe oil-coated and not at all conducive to a healthy discharge of compressed air. Even with good oil this condition might exist because it is due more to high temperature than to any other cause, and the best remedy available is to lower the temperature of the air before it starts on its journey to the mine. If this cannot be done during the process of compression, as is the case in plans already installed where the air is compressed in one stage only, considerable advantage may be gained by putting in aftercoolers; that is, air receivers provided with tubular passages for cooled water and thus acting as condensers to bring down the temperature and deposit oil and moisture at a place near the engine room where it can be cared for and kept in proper condition. This moisture and oil can be drawn out periodically as these aftercoolers or receivers are usually provided with proper man-holes.

Air-Compressors at the Düsseldorf Exhibition.*

The great number and variety of compressors exhibited at the Düsseldorf Exhibition bear evidence of the favor in which compressed air continues to be held in Germany as an agent for transmitting power in mine working.

The compressors shown are of very different types, both as regards their general arrangement and the details of their construction; but the fact deserves notice that they all belong to the category of "dry compressors." German makers appear to have quite given up the introduction of water, in greater or less quantity, into the cylinder, for neutralizing the influence of the dead space or clearance on the volumetric efficiency and for counteracting the heating of the air during compression.

In most of the compressors shown the cylinders are only provided with jackets and hollow heads, through which a circulation of cold water is maintained; but it is well known that, owing to the slight calorific conductivity of air, the cooling action of this jacket water extend but little beyond the working or cylinder surfaces.

Single stage-compressors of this type have necessarily a reduced volumetric output, at any rate when the final air pressure is considerable. Too much importance is sometimes attached to the volumetric efficiency or output. What is required of a compressor is the delivery of a large volume at the desired pressure. Now, with no water in the cylinder a much higher piston speed is permitted and such a compressor can be run at a much higher speed than those using water in the cylinder. This latter type rarely attain a speed of more than 50 revolutions per minute. Dry compressors, on the contrary, easily make from 150 to 200 revolutions per minute and sometimes more especially when fitted with suitable valves. It follows that, notwithstanding this low volumetric efficiency, the power of production in the case of dry compressors is far greater so long as the final pressure is moderate.

When, however, the final air pressure

*Abstract of a paper by Henri Dechamps, Ingénieur des Arts et Manufactures, communicated to the Liège Engineers' Association.

COMPRESSED AIR.

is high, dry single stage compressors cease to be efficient or safe. The delay in opening of the inlet valves, due to the presence of compressed air in the clearance space, occasions, in all compressors not provided with an arrangement characteristic of the Burckhardt & Weiss system, a diminution in the volumetric efficiency not compensated for by fast running.

The heating of the air increases the power required to compress it and renders lubrication difficult if not impossible. Also, owing to the great difference in the pressures on the two faces of the piston and valves, leakage may become considerable.

For high pressures German makers resort to multiple stage compression in two, and sometimes even three, cylinders. The exhibition does not contain a three-cylinder compressor; but those with two cylinders are numerous. They all comprise an intermediate receiver, cooled by water circulation, in which the air, after being partially compressed in the large or low-pressure cylinder, remains a sufficient length of time for its temperature to be brought approximately to what it was originally. The air, thus partially compressed, is then further compressed to the degree required in the small or high-pressure cylinder. Calculation shows the great advantage, for high pressures, of staged compression, both as regards diminished influence of the clearance spaces and the decrease of the power required to compress the air owing to its lower temperature.

As regards the character of construction, the compressors exhibited may be classed as those with freely working non-actuated valves or poppet, and those with actuated or mechanical valves.

The former class includes the compound horizontal compressor made by Schuchermann & Kremer, of Dortmund, for the Harpen Colliery Company, characterized by the adoption of Collmann valves. In this there are two valves at each end of each cylinder, one above for discharge and the other below for inlet; and these valves consist of well-guided annular discs with flat seats of aluminum bronze, having spiral springs for hastening their fall. For deadening the shock when a valve comes down upon its seat, there is an oil cushion, comprising a piston attached to the shank of the valve

and a cylinder carried by the frame. The periphery of this cylinder has a ring of circular orifices, which remain open during the greater portion of the valve's travel, and are only covered by the piston at the moment of the valve's closing, thus opposing the exit of the oil and suppressing the shock which is so difficult to avoid in compressors with lifting or poppet valves. The maximum number of revolutions is 70 per minute; and this compressor is designed for a piston displacement capacity of 5,200 cubic meters (183,646 cu. ft.) of air per hour and a final pressure of from 6 to 8 atmospheres (88 to 117 lb. per sq. in.).

All the other compressors exhibited run at a far higher speed, and their valves are designed in accordance. The compressor exhibited by the Humboldt Company is fitted with hinged valves on Professor Gutermuth's system, consisting of thin plates turning on a hinge and coming down on a grating. At each end of the cylinder, and at its lower portion an inlet and a discharge valve are placed in the same chamber, being arranged so as to reduce the clearance to a minimum.

The valves of the compressors shown by Rudolf Meyer, of Mulheim, are made of light steel discs with a very slight lift. These come down on seats cast with feathers. One of these compressors is direct connected to an electric motor and runs at 160 revolutions per minute.

The valves just mentioned realize, in different degrees, the Corliss principle of small valves with slight rise and requiring only the action of light springs to bring them sharply down on their seats, an insufficient cause for any considerable loss of load. This is also the principle carried out in the small compound air-compressor shown by Haniel & Lueg, which compresses the air to 65 or 70 atmospheres (mean 992 lb. per square inch) with a speed of from 150 to 220 revolutions per minute.

The compound compressor of the Gebrüder Meier, of Gladbach, making 125 to 150 revolutions per minute and compressing air to 6 or 7 atmospheres (mean 95 lb. per square inch), has a low and a high pressure cylinder, both single-acting and arranged in line, the space between the two pistons being in constant communication with the atmosphere. The air enters the low-pressure cylinder, while passing through the

Hörbiger inlet valves in the piston, while the delivery valves are arranged in the head—an arrangement which recalls one type of the Ingersoll-Sergeant compressor. In the small cylinder the inlet and delivery valves are grouped in the head, which is enlarged by splaying out the cylinder at its end.

Many makers consider that freely lifting or poppet valves do not afford the best method of closing the inlet and discharge ports in the case of a compressor running at a high speed, but in such a case prefer reciprocating valves, worked by an eccentric keyed on the driving shaft.

The Burckhardt & Weiss compressor, first exhibited at Paris in 1889, affords one of the earliest solutions of this problem; a compressor of this type shown by Fröhlich & Klüpfel, of Unter-Barmen, at the Düsseldorf Exhibition, contains several new examples of this class.

The compressors exhibited differ chiefly through the various methods of distribution adopted; but they all have certain characteristics in common. The distribution of air is effected in the same manner as in a steam engine, except that the air moves in a direction opposite to that of the steam. The air is introduced into the cylinder by the space corresponding with the hollow of an ordinary slide-valve and, after compression, is forced through the ports in the valve chamber, which communicates with the intermediate receiver in the case of a low-pressure cylinder, or with the compressed-air receiver in the case of a high-pressure with only one cylinder. Independently of the distributing valve there is always an additional part consisting of a retaining valve, kept closed by the pressure in the valve chamber and also by a spring. The object of this part is to cut off the inside of the cylinder from the valve chamber during the period of compression, until the moment when the storage (or final) pressure is attained. The retaining valve in the Burckhardt & Weiss compressor consists of a plate bearing against the back of the distributing slide-valve and travelling with it. In several of the compressors exhibited the valve is arranged on a fixed seat so as to take up, between the distributor and the valve chamber, as small a space as possible.

Besides the Fröhlich & Klüpfel, there is only one example of a flat side-valve, and this is in the compressor exhibited

by Paul Hoffmann & Co., of Eiserfeld. The slide valve, of wedge form, slides on two faces, one for inlet and the other for delivery; and the rectangular retaining plate of the Burckhardt-Weiss compressor is replaced by several circular lifting valves. This compressor is specially interesting because a single eccentric actuates the slide-valve of the air cylinder and also that of the Meyer valve gear with which the steam engine is provided.

The compressors shown by Pokorny & Wittekind, of Frankfort, are fitted with the Köster valve-gear, in which the distributor valve is a piston with two heads fitted with spring rings, as in the pistons that are often used for distributing steam in modern engines. This firm shows several such compressors, the most important of which is vertical, having a piston displacement of 7,000 cu. m. (247,216 cu. ft.) of air and compress it to 6 atmospheres (88 lb. per sq. in.) when making 100 revolutions per minute. It consists of two air cylinders, one high and the other low pressure, and also two steam cylinders, all four being arranged side by side, and the pistons connected to the four cranks of a shaft, made in two parts and carrying the fly-wheel in the middle. There are also two horizontal compound compressors with one single-acting cylinder and differential piston, making one 140 revolutions and the other 225 revolutions per minute, and also two single-cylinder compressors of which one, of small size driven by a belt, can make as many as 500 revolutions per minute.

The Köster piston is also used in the horizontal compound compressor exhibited by Neumann & Essert, of Aix-la-Chapelle.

A Strnad compressor, characterized by oscillating cylindrical valves like the Corliss plug valves, is shown by Th. Calow, of Bielefeld; and the Duisburger Maschinenbau Actien Gesellschaft has also adopted the oscillating cylindrical valve for its compressor which makes 120 revolutions per minute. This single valve, arranged in the middle of the cylinder, resembles an ordinary slide-valve; and it travels in a chamber of small size, separated by a retaining or discharge valve from the delivery pipe.

The Stahl und Eisen Company of Hörde shows two compressors fitted with

both mechanical and poppet valves, an arrangement designed by Professor Stumpf. The valves are actuated by an eccentric and are cylindrical blocks of the Corliss type, placed on the covers and serving only for inlet, the delivery being effected by spring-weighted valves also arranged on the covers; owing to this arrangement clearance space is very much reduced. The valve seats comprise two concentric portions, the outer being fixed, while the other is movable and sliding in the former. When the compressor piston is near the end of its stroke the spring parts on its face raise the movable seat and bring it towards the valve, so that the passage of air is interrupted just at the end of the stroke; and, directly the next stroke begins, the spring brings back the valve and its movable seat on to the fixed seat. One of the compressors exhibited is compound and makes 135 revolutions per minute, while the other has only one cylinder and makes 250 revolutions per minute.

J. W. P.

Compressed Air and Bore-Wells.

THEIR APPLICATION TO WORKS OF PUBLIC WATER SUPPLY.

The use of compressed air as a means of power transmission has been the subject of considerable difference of opinion amongst engineers, but the convenience it affords as a means of conveying power to long distances is a matter of such immense industrial importance that it has become an efficient and powerful agent in the hands of the present-day engineer.

The subject opens up a wide field for useful and interesting investigation, and demands the careful study of the engineer in its application to the very numerous uses to which it may now be advantageously put. In the course of the present article one of these uses will be more particularly dealt with—viz., the application of compressed air to the raising of water for public supply, from deep bore-wells, a plant of this description having recently been installed under the author's supervision at the Corporation Waterworks of Tunbridge Wells.

Every engineer who has had experience in the use of the various available agents for the transmission of power, such for

example, as steam, electricity, air and water, will doubtless have learnt their comparative efficiencies and have proved for himself that compressed air, when compared with the use of steam direct (if consumed on the spot where generated), is low in this respect. Compressed air, however, has its own peculiar advantages, which operate in special cases, thereby making it not only the most economical agent under certain circumstances, but frequently the only possible one. Cases often arise, as in mining, tunnelling, &c., in which compressed air is the only power-agent capable of performing the services required, and where questions of economy are of secondary consideration.

Compressed air is the only general mode of transmitting power to great distances large enough to be measured in miles, and is the only one which is always possible, no matter how the power is to be distributed or applied. Its adaptability, too, to the utilization of distant and otherwise unavailable sources of power render it a medium, the commercial importance of which can scarcely be over-estimated.

Considerations such as these led to the adoption of compressed air in the works above-named. Here it was found convenient to put down compressors at the pumping station, to supply them with steam from the existing boilers and so generate compressed air to be conveyed in a cast-iron main to two bore-wells 250 ft. deep situated about one-third of a mile distant, and to raise water therefrom to gravitate back to the reservoir and pump-wells at the main station.

The system is one which lends itself admirably to almost indefinite extension. Any number of wells may be put down in the surrounding country, within, say, a radius of 20 miles—the whole to be operated either individually or simultaneously from one central base by one staff. Thus, while the actual power cost of the air, or cost of fuel, per 1,000 gallons raised may exceed that of a separate steam-driven plant operating deep well pumps, there are many other items which go to make up the ultimate actual cost of the water obtained; and herein lie the advantages of a system of compressed air under circumstances similar to those described. All machinery may be centralized under one roof, and no work or buildings are required at the site of the well, beyond perhaps a single stand-pipe and rising main. At the outset, then,

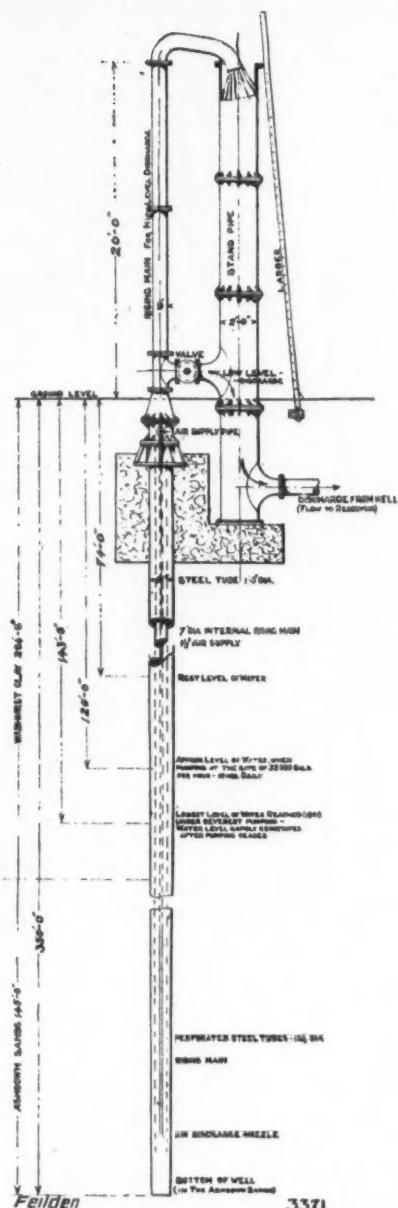


FIG. 1.—SECTION OF WELL, STAND-PIPE, COMPRESSED AIR-LIFT, ETC.

there is a saving in capital cost of the works. In working expenses the annual cost of supervision, labor, cartage of fuel to distant sites, repairs, rates and taxes, and numerous other incidental charges inseparable from the running of separate stations, are avoided. Under such conditions it would certainly appear that compressed air is the most economical power agent to employ, and, all things considered, that it is the most efficient means of bringing together for public supply a number of deep well waters.

The compressor plant under description is situated in the engine-house, at a point close to the boiler-house supplying steam to the large forcing engines which deliver the town supply into high-service reservoirs through some two miles of rising main against a head, exclusive of friction, of about 350 ft. These boilers are of sufficient capacity to yield the additional quantity of steam required by the compressor engines, besides other machinery at the works.

The compressors, to which further reference will be made later, compress the air by two-stage compression, first to 25 lbs. per square inch, and then, after cooling, to from about 90 to 100 lbs. to the square inch (but varying according to the depth of water levels in the wells), and deliver it into a reservoir or large steel receiver communicating with the length of 4 in. air main through which the air is conveyed to the wells. The connection and application of the air supply to the same are shown in detail in Figs. 1 and 3.

PLANT AT THE BORE-WELLS.

The plant at the bore-wells consists of a rising-main, air supply pipes, stand-pipe, and various valves and connections, and is illustrated in Figs. 1 and 3. Fig. 1 is a section of the well showing water-levels, rising-main, etc.

The well is sunk through the Wadhurst clay, which is over 200 ft. in thickness at this point, into the Ashdown sands, from which the supply of water is derived. The well is lined with steel tubes 15 ins. in diameter for its upper portion, and with perforated steel tubes 13 1/2 ins. diameter below.

The method of boring and the various tools and plant used in the processes of sinking the well will be referred to in detail later.

The rest-level of the water, when no pumping is being carried out, is 74 ft.

COMPRESSED AIR.

below the ground surface, and the approximate level, when pumping at the rate of 32,000 gallons per hour for ten hours daily, is reduced to about 120 ft. below the surface. The lowest water-level reached under the severest pumping with the present plant is about 150 ft., and the level is rapidly reinstated after pumping ceases.*

Inside the bore-well is hung a 7-in. diameter rising-main as shown in Figs. 1 and 3, through which the flow of the well discharges. The air-supply pipe, which the author has enlarged from 1½ in. to 2½ ins. in diameter, is suspended from

The effect of enlarging the air-pipe as above-named was to reduce the high-pressure gauge from 105 to 91 lbs. per square inch, the latter pressure corresponding exactly with the water level in the wells, thus showing no back pressure losses.

In an air lift it is important to get suitable conditions as regards depth of immersion or head of water over the air nozzle. When the water levels in the wells are well maintained, as when recommencing to pump after a period of rest, the discharge obtained is very large, ranging from 25,000 galls. to 30,000 galls. per hour

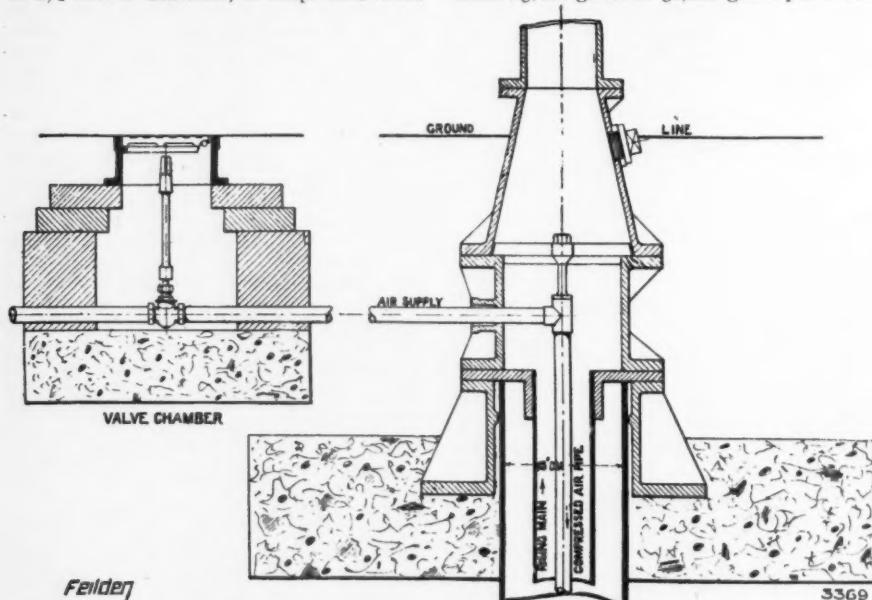


FIG. 3.—DETAIL AT TOP OF BORE-WELLS, SHOWING CONNECTION OF AIR SUPPLY.

the top of the well and hangs centrally in the 7-in. rising main, delivering its air-supply through a distributing nozzle or outlet near the bottom of the well. The action of the high-pressure air on issuing through the nozzle is to mix with and lighten the water-column inside the 7-in. tube through which it ascends, driving the water with it. The air is used expansively in the bore-well, continually expanding as it rises nearer to the surface, the pressure, of course, gradually getting less, until atmospheric pressure is again reached at the ground surface,

from one well. The gradual lowering of the water levels naturally reduces the rate of discharge proportionally, but the quantity yielded from a bore-well compressed air-lift under suitable conditions is considerably in excess of that given by ordinary deep-well pumps in the same size bore-well. In an air-lift system there is the great advantage of having no complicated mechanism in the well itself, such as rods, pump-valves, or other working parts, which may get out of repair.

The rising main is continued up to discharge into the top of a stand-pipe

20 ft. above the ground line to give sufficient "head" to deliver the water at the required elevation, or the discharge may be passed through the lower branch, near the ground-line, into the stand-pipe, if desired.

The effect of compressed air upon deep-well water is very beneficial to its use for public supply. It has the effect of aerating the water and hastening the precipitation of any iron that may be contained therein. It is also stated that in America, in cases where the capacity of wells have shown signs of decreasing the application of the compressed air-lift thereto has resulted in increasing the volume of water flowing from the well.

THE HORIZONTAL COMPOUND STEAM ENGINES
AND DOUBLE STAGE AIR COMPRESSORS.

Each compressor consists of one high-pressure steam cylinder, one low-pressure steam cylinder, one first stage and one second stage air-compressing cylinder, designed to be capable of delivering sufficient air to raise 16,000 gallons of water per hour from a varying depth of from 88 ft. to 150 ft. below the surface, to a tank over a standpipe at a height of 20 ft. above the surface of the ground.

The high-pressure steam cylinder is 8 ins. diameter, and the low-pressure steam cylinder is 12 ins. diameter. The 1st stage air-compressing cylinder is of 10 ins. diameter, and the 2nd stage air-compressing cylinder is of 6 ins. diameter. The stroke of all is 14 ins.

The compressors were designed to give the greatest efficiency in steam consumption when the depth of water is from 100 ft. to 150 ft. below the surface of the ground.

The high-pressure steam cylinder, the high-pressure air cylinder, and guide bar, all are bolted tandem-wise to one bed-plate, and the low-pressure steam and low-pressure air cylinders are bolted to a second bed-plate, one fly-wheel running in between the two bedplates.

The bedplate is of box section, 9 ins. deep, and has 3 ribs, 9 ins. deep, running the full length of the plates, two of which, forming the outside, have ample beading at bottom. The general thickness of metal is not less than $\frac{3}{4}$ in.

The bedplates are planed all over the bottom surface, the top surface being planed where needed to take cylinders, guide-bar, pedestals, and the necessary brackets.

In the air compressors both the first and the second stage air cylinders and the end covers are water-jacketed. The air is first compressed by the first-stage cylinder into an intermediate water-cooling vessel, from which it is drawn and further compressed to the full pressure required by the second-stage air cylinder. The piston-rod is connected to the tail-rod of the steam cylinder. The cylinder is of special close-grained cast-iron accurately bored to take pistons.

The compressor valves of all cylinders are of Messrs. Hughes & Lancaster's patent Corliss type, and operated by single eccentrics.

The specification provided that the arrangement of valves should be such that the following conditions should be obtained:—

(1) The valve to be opened and closed mechanically for suction to avoid any "wire-drawing," and to make certain that the valve shall close at the right moment viz.,—at end of stroke of piston, to prevent any leakage or slip past the valve.

(2) The delivery valve to be shut mechanically to prevent slip, but to be opened automatically by the pressure in the cylinder. The delivery passages to be as small as possible consistently with keeping sufficient area.

(3) The clearance in the cylinder to be not more than 1 per cent. of the volume swept out by the piston. The air imprisoned in the Corliss valve to be returned to the cylinder during the compression stroke to prevent any further loss in volumetric efficiency.

(4) The valves to work without shock, and to be practically noiseless when running at the highest speed the compressors are likely to be run at.

(5) The valves to be capable of being removed for inspection and replaced with the minimum loss of time.

(6) The driving gear to be so arranged that the valve can follow up its wear readily.

(7) The pressure on valve faces to be so balanced that there is no undue friction, and yet there shall be sufficient pressure to make a perfect joint between inlet and delivery passages.

(8) The barrel of cylinder and as much as possible of cover to be water-jacketed, but so arranged that they can be readily

cleaned out in case any sediment should be deposited in water-jackets.

(9) The incoming air must not come in contact with any heated surface till it reaches the inlet air valve.

The steam cylinders are made of special close-grained cast-iron, accurately bored to take liners; the steam chests are the full length of cylinders and of ample width, the liners are of the very best close-grain cast-iron, free from blow-holes and accurately bored to fit pistons.

The space between liner and cylinder forms steam jacket and is about $\frac{3}{4}$ in.

The cylinders, end covers, and steam-chest covers, are lagged with fossil meal and sheet steel, and are provided by drain cocks, tallow cups, and the necessary copper pipes, valve, etc., for connecting steam jackets to steam chest and steam traps. The drain cocks are connected by lever in such a manner that both can be operated by one movement. A sight-feed lubricator is provided on steam branch to high-pressure steam cylinder.

The pistons are of cast-iron of good construction and fitted with broadcast iron-spring rings.

The piston-rod and valve-rods are of steel turned accurately to gauge.

The slide-valves of the high-pressure steam cylinders are on the Meyer cut-off expansion principle and are capable of being adjusted whilst the engine is running, so that the cut-off in the cylinder may be altered from quarter to three-quarter of the stroke. A pointer shows accurately on a scale the position of the cut-off.

The slide-valves of the low-pressure steam cylinders are of the ordinary "D" type.

The crosshead is of improved design, made of cast-steel, and fitted with adjustable cast-iron slippers top and bottom, having very large wearing surfaces.

The connecting-rod is of marine pattern, is made of steel, and machined bright all over. The large end is fitted with gun-metal steps, having large wearing surfaces.

The eccentric straps and sheaves are of cast-iron, and the rods of mild steel finished bright all over. The straps are fitted with sight-feed lubrication arrangements.

The crank-shafts are of mild steel, finished bright all over, made in two pieces, and are accurately turned where required to fit plummer-blocks, connecting-rod brasses, fly-wheels, etc.

The fly-wheel is about 15 cwt., 5 ft. diameter by $4\frac{1}{2}$ ins. wide, is turned on face and edges. It is keyed on to its crank-shaft by two keys.

The steam cylinder is provided with a screw-down stop valve of approved type.

The valve-rod glands are of gun metal, and the piston-rod glands are of cast-iron, bushed with gun metal.

The lubricating arrangements are such that the compressors can be run without stopping for a considerable length of time. All lubricators are of the siphon or sight-drop types; guide bars, crosshead pins, eccentrics, and main pedestals are lubricated by adjustable sight-drop lubricators.

The engines are neatly painted, and are provided with the requisite foundation bolts and plates, and a set of spanners.

In a test recently run 321,870 gallons of water were raised in $10\frac{1}{4}$ hours from one bore-well from a lift of 133 ft.

COMPRESSED AIR-LIFT AT ARAD.

Another interesting example of air-lift is that at the Arad waterworks in Hungary, where there are two 9-in. boreholes each capable of delivering about 32,400 gals. per hour, only one of which, however, is usually in use at the same time, as this rate of delivery is found sufficient for the present needs of the town.

The water supply is obtained in the gravel stratum below an impervious bed of clay about 20 ft. in thickness, the bottom of which is some 63 ft. below the ground surface.

The compressed air is carried down the bore-pipes by means of wrought-iron tubing, issues through a suitable nozzle, and raises the water into the cast-iron service well or unfiltered water-tank.

The steam-engine air compressor for generating the air supply have compound steam-jacketed cylinders 11 ins. in diameter and 18 ins. stroke. The exhaust steam from the engine is carried to a surface condenser placed below the floor of the engine-house. The circulating water for the condenser is supplied by the pipe conveying the water from the service well to the filters.

There is an automatic arrangement in connection with the air-lift for intermittent working, as the supply of water reaching the well is insufficient for a constant flow. The water is cooled and aerated by the action of the compressed

air. This plant was laid down by Messrs. Hughes & Lancaster.

THE WALLASEY AIR LIFT.

To meet the growing needs of their district, the Wallasey Urban District Council recently found it necessary to utilize fully their existing available water sources, and decided to install an air-lift plant for raising water from No. 1 bore-well at Poulton, being satisfied that a much larger quantity could be obtained therefrom than it was found possible to extract with the old deep-well pumps.

The air-lift plant was installed by the British American Well Works, of Queen Victoria Street, London, and consists of a set of horizontal combined engines and stage air-compressors, the steam engines being placed side by side and work tandem on to the air-compressors. After leaving the low-pressure cylinder the air passes through an inter-cooler and then on to the high-pressure cylinder. Water-jackets surrounding the air-cylinders also cool the air during compression. The high-pressure air is led away through an air main to a receiver, and from there to the wells.

The Poulton well is of 10 inches diameter and 700 feet deep. The old pumping machinery was giving about 7,200 gallons per hour, and the makers of the air-lift undertook to increase this yield to about 32,000 an hour.

The system is in use at various breweries, public baths, and manufacturing establishments in various parts of the country.

BORE-WELLS.

Where suitable geological conditions obtain, the sinking of bore-wells to secure deep-seated waters is a useful means of largely augmenting the sources for purposes of public supply.

These wells are sunk in diameters varying from 3 inches up to about 45 inches, and to almost any required depth up to about 3,000 feet.* Two borings of the Wallasey Urban District Council, in addition to those already referred to, are each of 33 inches diameter, and 810 feet and 910 feet in depth respectively. These were sunk by Messrs. Mather & Platt, Limited, of Manchester. The same firm have put down, amongst many others, a boring at Lackenby (near Middlesbrough).

*At Schladbach (Prussia), the deepest bore-hole in the world was put down, it having reached a total depth of 5,734 feet.

of 1,806 feet in depth, and two of large diameter (40 inches) at Rickmansworth.

Borings of this class are sunk by the aid of the "Rig Boring Machine," a plant made by Messrs. Mather & Platt, which comprises the requisite steam engine and hoisting gear, etc., all combined in such a manner that one man can control all the several working parts.

With this machine the boring is done by means of a round rope 2½ inches diameter, at the end of which is suspended the jars, and the boring-bar and head into which is fitted from one to four chisels.

The up-and-down movement is obtained from the walking beam, whose motion is actuated by means of a crank driven from the engine driving the boring plant. The boring bar is turned round by the man on the surface, who moves it by means of a lever attached to the rope.

In the Mather & Platt machine a flat rope is used, and the up-and-down movement is performed by means of the steam pumping cylinder between the uprights of the machine; the boring bar turns round automatically by means of the ratchets on the top portion of the bar.

With each type of boring machine, a similar type of sludge-pump is used for getting the debris out of the bore-hole.

The general principle of boring in hard rocks is the piercing or cutting a hole by continually repeated blows of sharp chisel-ended drills, or a number of such fixed in a metal block, a rotation being kept up so that no two blows in succession strike on the same spot.

In commencing operations a well or pit of about 8 ft. to 10 ft. diameter is sunk to about 10 ft. or 12 ft. deep, and the boring then put down at the centre. The boring tools are attached to iron rods, which are screwed together in 10-ft. lengths as the boring descends.

The various tools and plant employed in boring the wells we have had under consideration are of interesting variety, and have to be selected and changed from time to time according to the class of materials met with in the sinking of the bore. The under-mentioned are some of the principal tools used, as made by Messrs. J. Warner & Sons, of Cripplegate, with their various purposes assigned thereto (Figs. 16 to 52).

Fig. 16.—Shell Auger, for boring in clay and hard soils.

Fig. 17.—Shoe-nose Shell, with loose valve for boring in sand and loose soils.

COMPRESSED AIR.

Fig. 18.—Auger-nose Shell, with loose valve for boring in loamy sand.

Fig. 19.—Bell-mouth Shell, with loose valve for boring in shingle and coarse sand.

Fig. 20.—Auger Shell, with metal valve for boring in sharp sand or fine grit.

Fig. 21.—Diamond or Drill Point-Chisel, for boring in hard soils and sandstones.

Fig. 22.—Flat Chisel, for boring in flint or stone.

Fig. 23.—Tee Chisel, for boring in flint or stone.

Fig. 24.—S Chisel, for boring rocks.

Fig. 25.—X Chisel, for boring rocks.

Fig. 26.—V Chisel, for boring rocks.

Fig. 27.—Worm or screw Auger, for boring soft stone.

Fig. 28.—Parallel Worm Auger, for boring chalk or marl.

Fig. 29.—Plug Drill, for clearing and straightening boreholes.

Fig. 30.—Bell box, with cleats, for withdrawing broken rods by passing over the swelled joints.

Fig. 31.—Bell Screw, for withdrawing rods by catching broken rod screws.

Fig. 32.—Spiral Worm or Miser, for withdrawing loose stones or broken rods from bore-pipes or holes.

Fig. 33.—Bow Dog, for lowering or raising bore-pipes.

Fig. 34.—Spring Dart, with extra tongues for raising faulty pipes.

Fig. 35.—Crow's Foot, for extracting broken rods.

Fig. 36.—Swivel Rod, for turning the tools without twisting the rope.

Fig. 37.—Boring Rods, in 10-ft. lengths, with turned joints and universal male and female screws, made of 1 in. sq. iron for 2-in. and 3-in. borings to 100 ft. deep.

1½ in. sq. iron for 4-in. to 6-in. borings to 400 ft. deep.

1½ in. sq. iron for 7-in. to 8-in. borings to 600 ft. deep.

1¾ in. sq. iron for 9-in. to 10-in. borings to 1,000 ft. deep.

Fig. 38.—Tillers or Levers, for turning rods.

Fig. 39.—Lifting Dogs, for raising or lowering rods.

Fig. 40.—Spring Hook, for attaching to rope for lifting purposes.

Fig. 41.—Rod Wrenches or Hand Dogs, for screwing and unscrewing rods.

Fig. 42.—Scotches, for holding up rods over on boring boards whilst being screwed together or being disconnected.

Fig. 43.—Auger Cleaner, for removing clay, marl, or chalk from augers.

Fig. 44.—Auger Boring Board, for resting and guiding tools for cleaning, connecting, or examination.

Fig. 44a.—Snatch Block, for lifting rope.

Fig. 45.—Rope Pulley, for lifting rope.

Fig. 46.—Tee Screwdriver, for varied purposes among tools.

Fig. 47.—Shear-Leg Fittings, for connecting and binding ends of legs.

Fig. 48.—Pipe Tongs, for making joints.

Fig. 49.—Steel Pipe Shoes, for protecting and sharpening cutting edge of pipes.

Fig. 50.—Cast-iron Screwed Driving Cap.

Fig. 51.—Flush Screw-Joint Bore Tubes of welded wrought-iron, made in 6-ft., 8-ft., or 10-ft. lengths, with lapped joints.

Fig. 52.—Swelled-Joint Bore Tubes of welded wrought-iron, made in 6-ft., 8-ft., or 10-ft. lengths, with lapped joints.

A complete set of boring tools suitable for boring to 800 ft. or 1,000 ft. deep, with the necessary strong 1½-inch boring rods with turned screwed joints, may be obtained at a cost of about £200.

An interesting example of an artesian well sunk through the oolitic strata in 1856, in this district, yielded about half a million gallons of water per day under a pressure sufficient to supply the town without the aid of pumping power.

In the earlier portion of the present article particulars were given of the raising of water from deep bore-wells by means of a compressed air lift; at the site of the same works there are also two bore-wells fitted with steam-driven deep-well pumps.

The bucket and suction valves are placed at a depth of about 203 ft. below the engine-house floor in a gun-metal pump barrel 4 ft. 9¼ in. in length and 8½ ins. in diameter. The plant, running at 27 revolutions per minute, delivers about 16,000 gallons of water per hour. The pumps were installed by the well-known firm of Messrs. James Simpson & Co., Ltd., of Pimlico, and have been working for about six years with every satisfaction.—WILLIAM H. MAXWELL, A. M. Inst. C. E., in *Feilden's Magazine*, London.

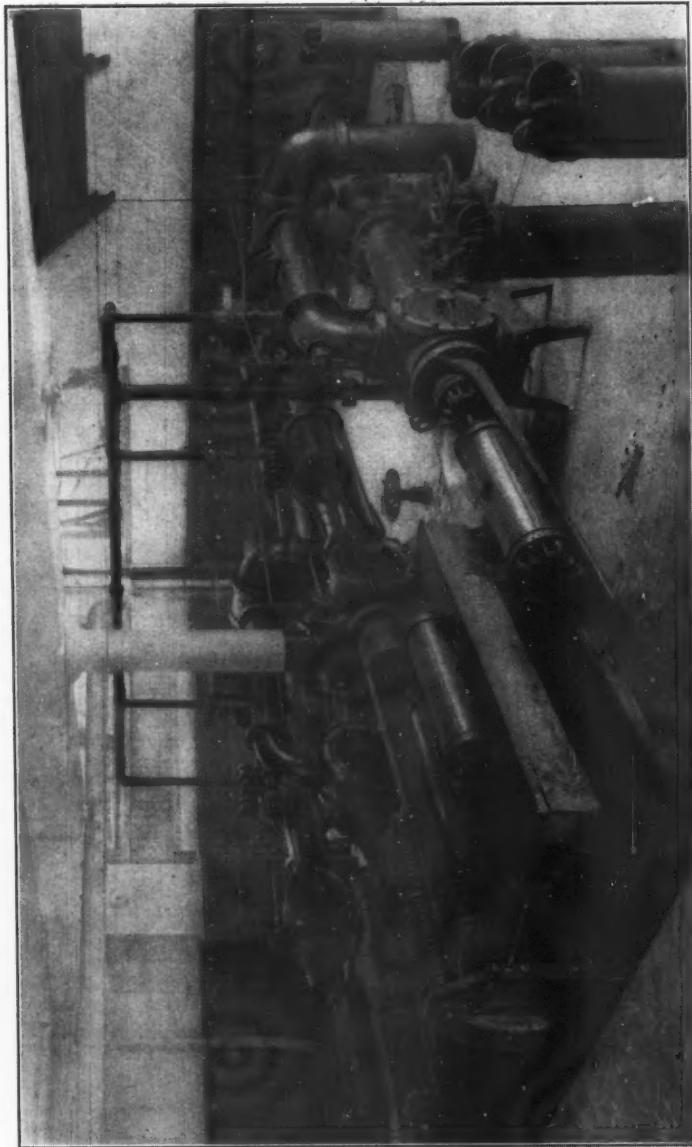
The Boston Pneumatic Tube Service.

The problem of delivering packages is one that confronts every retail dealer in every line of goods. The wholesale merchant can confide his goods to the railroad or steamship company, knowing that at the other end his consignee will unload and take care of the shipment. But the distributor is facing a different problem. He must leave his goods at the homes of numerous customers, each and every one of whom expects his order to receive immediate attention. This becomes a serious matter in the large cities where the population covers a vast area.

The American Pneumatic Service Company has instituted a novel method of distributing parcels by installing an underground pneumatic tube system in Boston. A central station has been erected in the very center of the retail shopping district at the head of Harrison avenue. From

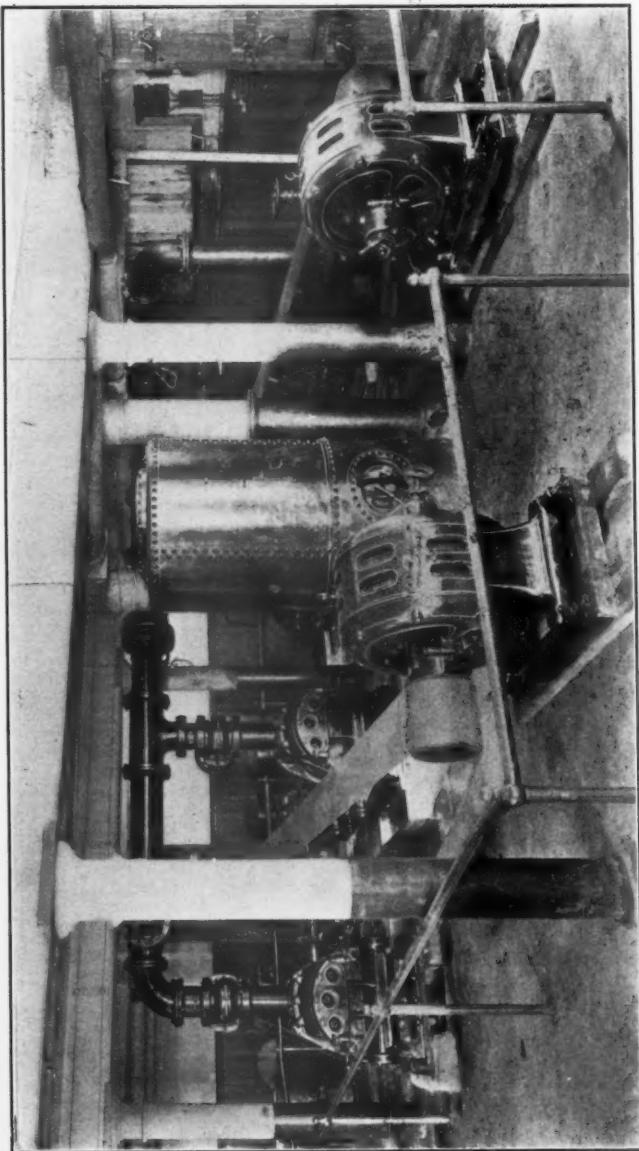
COMPRESSED AIR.

1966



TERMINAL STATION.—BOSTON PNEUMATIC TUBE SERVICE.

COMPRESSED AIR.



ELECTRICAL DRIVEN AIR COMPRESSORS.—BOSTON PNEUMATIC TUBE SERVICE.

this station two pairs of tubes are laid, one pair running to the Back Bay sub-station on West Newton street near Huntington avenue. The other pair runs to the south end sub-station on Washington street, near Brookline street. From the south end the line is continued to the Dudley street station in Roxbury, near the terminal of the elevated road, and from Roxbury it runs to the Dorchester sub-station at Upham's Corner. The parcels are collected from the stores by teams and brought to the central station. There they are sorted and sent by tubes to the sub-stations above named, and delivered from them by team or messenger. The average time of transit from the central to the Dorchester station is about 10 minutes as against 40 minutes by team.

compressor. Only such air has to be dried as is lost through leakage or used for operating the machines.

The compressors are duplex belt-driven with 24 in. x 12 in. cylinders. There are two each at the main, south end, and Roxbury stations, and one each at Dorchester and Back Bay. The compressors are driven by 50 H. P., three-phase induction motors of the internal resistance type. The idea of belted compressors and electric motors was adopted after a long investigation into the relative merits of steam, gas and electric power. Steam was early abandoned because of the necessity of having a licensed engineer at each plant, and on account of the room required for boilers, coal bunkers, etc., gas engines appeared attractive on the score of economy,

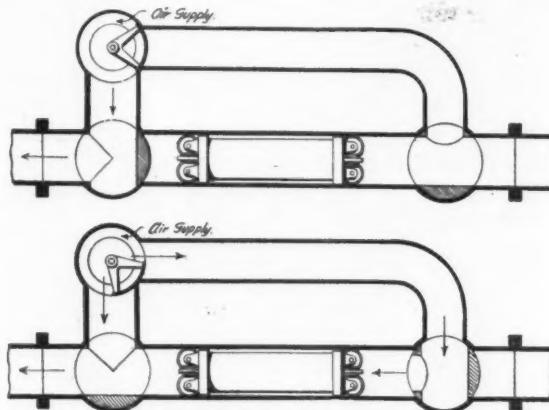


DIAGRAM SHOWING AIR LOCK.—BOSTON PNEUMATIC TUBE SERVICE.

The tube is operated by compressed air, which forces a carrier along in a manner similar to that in use in the familiar store service cash system. The air required is about 1,400 cubic feet per minute at an average pressure of 1.9 lbs. With the lines filled with carriers this pressure may rise to as much as 2.1 lbs., and in the shorter lines, with no load, it falls off to 1 $\frac{3}{4}$ lbs.

Before entering the compressors the air passes through a tank filled with calcium chloride, which effectually removes all moisture. This tank is open to the atmosphere, and the pipe connections are so arranged that the air of the incoming line passes through the tank and returns to the

but it was decided that a power was needed that could be more easily controlled; that is, one where the starting or stopping of the compressor would be an easier matter. Turning naturally to electricity, the decision lay between direct and alternating current. The induction current motor with no commutator to burn out, with no danger of burning out the armature, and its high efficiency at half load, was finally adopted. The motors have been running for a year, without giving the least trouble, and with a total bill of repairs of less than five dollars, all of which was for paint.

The carrier used is a complete departure

from all previous designs. Instead of using felt or some other substance for bearing rings on which the carrier can slide, five wheels are placed on each end of the carrier. The heads which carry the wheels are slightly flanged and it is found that the air that leaks by is not sufficient to be noticeable. The cover is hinged on the side, opening the whole length of the carrier, and nearly one-half its circumference. It is locked by a trident at each end which

nearly to rest the auxiliary over-balances and moves the controlling valve of the main cylinder. This opens the revolving valve and allows the carrier to roll out. Just at the end of the receiver two vanes are mounted so that the pressure of the air behind the carrier tends to move them. This motion is made use of to restore the auxiliary valve to normal position and close the receiver. As the current of air is kept flowing all of the time, it is necessary to have some method



PARCEL CARRIER.—BOSTON PNEUMATIC TUBE SERVICE.

slips into holes drilled in the head. Such a heavy carrier cannot be allowed to come out of the open end of the tube the way that small carriers do in the store service systems. The receiving terminal is an air cushion closed at one end by a revolving valve which is opened and closed by a cylinder and piston operated by compressed air from the tube. Normally this valve is closed. When the carrier enters the receiver it compresses the air in front of it. This pressure affects a small auxiliary valve. When the carrier is brought

of introducing the carrier into the tube. This is done by a simple adaptation of the air lock (see diagram). The valves are moved in the proper sequence by one cylinder controlled as in the receiver.

The pipe used is cast-iron water pipe, machined at the joints to make a close fit. It was laid in the same manner as water pipe, with lead and yarn joints. The curves are of cast-iron, 12 feet radius to center line, the circular section of the straight pipe becoming elliptical at the bend. The bends were cast in sections,

the standard 90-degree bend consisting of three 30-degree sections bolted together. In laying, the usual obstacles of manholes, sewers, water and gas pipes and electrical conduits were encountered. To add variety to the work, the foundations of the elevated road and the roof of the subway had to be avoided. On Harrison avenue a long stretch of soft mud was encountered which made it necessary to excavate below grade and put in a bed of good bank gravel. This, when well rammed, made an excellent foundation. Work was commenced Sept. 4, 1900, and the first carrier was sent through on March 10, 1901. Business was commenced June 1, 1901, and has been carried on steadily ever since.—E. D. SABINE, in *Railroad Gazette*.

Water Supply from Deep Wells by Air Power.

The results obtained from the trials made with the air lift pump installed at the Ilford District Council's electric power station go to show that a revolution in the economical raising of water from deep wells has been accomplished. As a consequence of this invention of Mr. Joseph Price, C.E., of Messrs. Le Grand & Sutcliff, it is likely that the expensive deep well pump will before long be superseded. These deep well pumps, which require to be fitted immediately above the bore well in order to provide water for use in towns, for supplying power stations, or for draining mines, have been the source of much trouble. A breakdown of a single detail of the pump machinery overhead or a little grit or sand in the foot valve underneath has frequently caused the supply of water to be cut off for periods ranging from three days to three weeks at a time. The introduction of the air lift pump will reduce these failures to a minimum, and any quantity of water will be provided from artesian wells sunk in batteries each at a convenient spot, while the air power for working them will be distributed through a small and inexpensive pipe from a central station conveniently situated alongside the railway line, by the coal mine or at the waterfall. Formerly each well required an expensive deep well pump and a house for protection directly over it, now twenty or thirty wells may be supplied with

power from one machine under one roof, and each bore pipe will supply more than double the quantity of water which would have flowed from it under the old conditions.

As far back as 1797 Mr. Carl Emanuel Löscher, surveyor of mines, described a system of raising water by aerostatic apparatus by means of which well water could be raised to a height of 375 feet. In this experimental apparatus of Löscher a pipe was placed in a receiver filled with water, part of the pipe being above water and part under the water, while a current of air under pressure was forced down an inner pipe, the bottom of which was open to the outer pipe. The air forced down the water which had risen in the inner pipe, and mixed with the water inside the outer pipe. The air mixing with the water made it lighter and caused it to rise in the annular space between the two pipes. The water thus lightened rose above its ordinary level to a certain height which depended on the pressure of the air rarifying the water. By making an opening in the outer pipe below the level to which the water had risen in it the water could be drawn off from the receiver. Thus water could be pumped from a well by the apparatus with a supply of air.

Löscher's was simply an experimental apparatus, for no practical application was made of it. It was not until 1846 that Mr. Crockford in America took up the idea and constructed apparatus, on the principles explained above, to pump petroleum from several Pennsylvanian wells. Dr. Pohlé applied the principles on a large scale for raising water in America. In 1885 Mr. Werner Siemens fitted out a number of pumping plants in Germany on this system, and then Messrs. A. Borsig, of Berlin, began to construct and fit the apparatus for pumping under the name of Mammoth pumps. One of these pumps was presented to the Machine Laboratory of the Technical High School at Berlin.

The observations made while this pump was working at the Technical High School are interesting, and a record of them goes some way to supply an explanation of the principles under which the apparatus has been designed, so we give them here. There is an artesian well pipe of $6\frac{1}{4}$ inches diameter sunk to a depth of 100 feet below the surface of the ground. The pump proper and its

two pipes are fixed at the bottom into a foot box. To allow of observation being made the upper part of the rising main was made of glass tube. It was arranged that the rising main should discharge freely into a reservoir. When the air is pumped down the air tube it flows out at the foot into the box and then up the rising main and causes the water to rise. Air bubbles are seen to ascend, and by an entraining action draw the water after them. The water is indeed seen to be mixed with air bubbles of the size of peas and with foam. In some of the intermediate spaces the mixture contains very large volumes of air, which fill the whole section of the rising main, so that there are alternately layers of foamy water and layers of air. The water is sometimes seen to fall back a little, in consequence, probably, of the air going up and leaving the water behind.

The force which causes the water to rise in the rising main is the pressure of water round it, and the pressure depends on the height it stands in the well. The height to which the water can be raised will therefore depend on the pressure outside. To obtain greater pressure of water in the well it must be sunk deeper, so that the height to which the water has to be raised determines the depth to which the well must be sunk. As a rule the water column should be from one to one and a-half times the height to which it is desired to raise the water.

It has been mentioned that one of the great advantages of the air lift pump is that the working parts may be at a great distance from the well, and, indeed, in the power station under easy control of the engineer. Another advantage, which is really a consequence of the above, is that as soon as the pressure of air in the supply pipe has been raised to that of the water at the foot of the well the pump begins to give off water. This is brought about simply by the turning of an air cock. There is a yarn spinning factory at Zurckau, where a water engine takes 4 cubic metres of water per minute from the river Mulde, and raises it to a height of about 30 feet at the works, a distance of 1,000 yards away. In this case the water first frees itself of air and then flows into an open receiver. This receiver or supply tank requires to be placed at a considerable height to give sufficient head to drive the water through the pipes. The tank stands at a height

of 44·16 feet. The air at the required pressure for driving the pump is obtained from the factory by means of a steam compressor. During the winter, when the pumping appliances are not in use, the upright portion of the discharge pipe which is not sunk in the ground is provided with an automatic discharge valve at its lowest point, so as to protect it from frost. It is arranged to be so connected with the compressed air pipe that it is opened by a spring so soon as there is no more pressure. It has been mentioned above that a much greater discharge of water can be obtained from the air lift pump than from a deep well pump of equal size. At Poulton the Urban District Council of Wallasey had an old deep well pump which lifted 7,200 gallons of water an hour. An air lift pump was fitted in of the same dimensions, and it now gives a discharge of 32,000 gallons an hour. At another place the well has been sunk 200 feet down through the Wadhurst clay into the Ashdown sands, from which the water is obtained. The well is formed of 15-inch tubes above, and perforated steel tubes below of 13½ inches diameter. When no pumping is going on the water stands in the tube at a level of 74 feet from the ground, but when water is being pumped from the well at the rate of 32,000 gallons an hour for ten hours a day, the water level sinks down to a point 120 feet below the level of the ground. The lowest point the water has reached is 150 feet from the ground. Inside the bore well tube there is suspended a rising main of 7 inches diameter. The air supply pipe is suspended inside of that, originally this pipe was 1½ inches diameter, but by increasing its diameter to 2½ inches diameter the engineer-in-charge found that he could reduce the pressure of the air supply from 105 lbs. to 91 lbs. with advantage. The pressure of 91 lbs. is exactly equivalent to the water level in the wells.

The efficiency of the ordinary system of deep well pumping at the beginning, when everything is new and it is working very smoothly, is as high as 50 to 60 per cent. Afterwards, when wear and tear and valve troubles have set in the efficiency may be reduced to about 40 per cent. The efficiency of the air lift system is not so high. At the Kent waterworks the efficiency is probably as high as anywhere, and yet it does not come above

25 per cent. Still there is the advantage of the system requiring only one power house at any convenient spot supplying power to any number of wells as against the deep well pump with a complete pumping plant and house to cover it above every well.

The new air lift pump designed by Mr. Price saves some of the waste of power inherent in the design of the ordinary air lift pump. The rising main of the ordinary air lift pump is of equal diameter throughout, and it has been seen in the experiments made by Prof. E. Josse that layers of air rise in the main alternately with layers of water. It is of interest, and an explanation of the action of the air as it rises in the tube will be suggested if its changing conditions throughout the passage upwards be considered.

Take, for illustration, a case where the lift is 80 feet and the corresponding immersion is 120 feet, thus making the total length of the rising main 200 feet. To overcome the 120 feet resistance of immersion the air must be compressed to 60 lbs. gauge pressure or five atmospheres absolute pressure, and will thus occupy one-fifth of its original volume. Now as a layer of air rises in the main the pressure above it will become less and less, and at the top will only have the pressure of the atmosphere on it. If it can it will expand gradually on its way upwards until at the top it will occupy a length of tube several times greater than it did at the bottom. In order to permit this expansion the water above the layer of air must have been caused to travel very much faster than it did at the bottom. That is to say, much of the energy of the air has been uselessly applied to give a rapid motion of the water in the upper parts of the tube.

In order to get over this difficulty, Mr. Price, of Messrs. Le Grand & Sutcliff, has introduced a rising main narrow at the bottom and gradually widening towards the top. By this arrangement the air can expand laterally, and the layers of water travel with little greater speed at the top of the rising main than they did at the bottom. There is thus a saving in the expenditure of energy in giving more momentum to the water.

Results have been obtained from an air lift pump constructed to effect economy in the air supply at the electric lighting and power station of the Ilford District Council. The well is sunk in the yard,

and the immersion is $1\frac{1}{2}$ to 1 of lift; this lift being 130 feet. The air pipe is $1\frac{1}{2}$ inches diameter at the top of the well, and this is reduced to $1\frac{1}{4}$ inches lower down. The air is supplied by an Alley & McLellan compressor, which on trial gave the following results:—When the air pressure in the receiver was 80 lbs. the mean i.h.p. of the air cylinders was 18.83, when 100 lbs. 22 i.h.p., and when 120 lbs. it was 24.3 i.h.p. On trial with one of these air compressors directly driven with a steam engine the loss was only 6 per cent. At Ilford the compressor is driven with a Bruce Peebles motor.

Starting from rest the full pressure is shown in the receiver in quarter of a minute, and water is running through the pipes after one minute. A curious phenomenon is seen just after the water runs out of the supply pipe. There is a relief or head tank fitted some distance from the well, and as soon as the water begins to run a great rush of air and water springs up through a hole in the top of the tank. Placing the hand over the hole when the pump is in action one feels a curious throbbing action. The hand is alternately blown upwards and sucked into the tank. It is probably in consequence of a layer of air suddenly expanding and blowing everything out in front of it and then the atmosphere pushing back and reasserting itself.

A notch gauge for measuring the quantity of water supplied by the well has been fitted up, and the quantity measured is 12,000 gallons an hour. A deep well pump which would go down the same boring would only deliver from 4,000 to 5,000 gallons an hour. The speed of the motor is 790 revolutions, and the pump makes 71 revolutions per minute.

As regards economy and efficiency, the system has been compared with similar steam deep well pumps and ordinary air lift pumps. To do this the efficiency of the air compressor when driven by a direct-acting steam engine must be taken. It has been mentioned that the loss on trial of a compressor driven by direct-acting steam engine was found by Messrs. Alley & McLellan, the makers, to be in one case 6 per cent. Taking 10 per cent. as the loss at the compressor, and 20.5 as the mean i.h.p. of the compressor cylinders, then with a supply of 12,000 gallons an hour, a pressure of air at 90 lbs. and a lift of 130 feet, which were

COMPRESSED AIR.

the figures read at trial, the efficiency works out at 35 per cent. Improvements on these first few installations will increase the efficiency, so that when the cost of repairs, maintenance, and small comparative supply of the deep well pump, and the wide range and large supply afforded by these new air lift pumps are considered, the working cost in all charges, it is apparent, can easily be brought down below that of the deep well pump. When this pump is compared with the ordinary air lift pump with straight rising main it is only necessary to point out that the efficiency is 42 per cent. higher even in the first wells tried at the Central London Railway, Shepherd's Bush, and at Ilford power station.

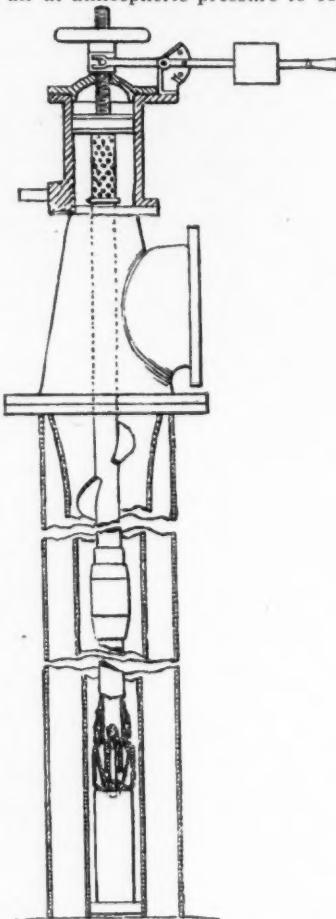
Since we wrote the above, further trials of the plant have been made. The efficiency test of the plant was made on the 16th of July, 1902, and the following were the particulars supplied by the contractors. The well is bored 10 inches diameter to 400 feet in depth. The height to which the water rises when at rest before pumping is 44 feet below the surface.

The plant was arranged as for raising a supply of 10,000 gallons from 130 feet below to 20 feet above the surface and (excepting as regards the design of the tubes) on lines dictated by the best American and German practice for parallel rising mains. The wells of American and German design require about 144 cubic feet of air to be compressed for the above duty, equalling a ratio of at least $5\frac{1}{2}$ volumes of air to one of water, and a ratio of submergence to lift of 3 to 2.

The rising main of Mr. Price's pump consists of tubes increasing in inside area. As the air expands in rising, the friction of the water is greatly reduced as compared with pumps with parallel rising mains. The internal air tube has an adjustable annular ejector to enable those operating the pumps to economize the air used. By this means the velocity of discharge of the air at the depth of 336 feet below the surface is utilized. The water, while the trials proceeded, was discharged at 5 feet above the surface over a weir fitted with a gauge for recording the quantity of water discharged per minute.

In the case of Ilford the air compressor is about 50 feet from the well. It is of

the two-stage type with intercooler, and has been found to compress 144.2 cubic feet of air at atmospheric pressure to 100



PRICE'S PUMP SHOWING TAPERED RISING MAIN.

lbs. pressure when working at 115 strokes a minute and indicating 22 h. p. in the compressor. The compressor is driven through gearing by an electric motor fixed on the same bed-plate.

Under the contractor's trials the plant was run for fourteen days and nights, and kept the water lowered to an average depth of 127 feet from the surface, the lift being 132 feet. The average flow

over the weir gauge was 11,660 gallons per hour, that is 195 per minute.

During the run it was found that the compressor working normally was doing much more than was required, and that a quantity of the air could be allowed to leak away without in the least reducing the flow of water. The quantity of air leaking away in this manner was measured, and found to be about 44 cubic feet. So that really the quantity of air required to lift the quantity of water measured was only 100 cubic feet per minute. This works out to be a ratio of 3:2 volumes of air per volume of water lifted under the conditions stated.

On the completion of the above test arrangements were made to slow the motor down, and this was done until the pump made 83 revolutions per minute. At this speed the quantity of water raised was 200 gallons per minute, the total lift being 124 feet. With these data the volume of air is 3:25 volumes per volume of water. This comes out about the same as was found by the leakage operation.

From these figures it becomes an easy matter to calculate the efficiency of the system of pumping water. For lifting 200 gallons of water through a height of 124 feet is equal to performing 248,000 foot-lbs.; and the power used in doing this is 15.88 h.p., which is equivalent to 524,000 foot-lbs. This shows an efficiency of 47 per cent.

But in this case the pump was working under certain disadvantages. The excess of the submergence over the standard was 31 feet, and the temperature was 80 degrees Fahr., that is, 25 degrees Fahr. above the normal temperature. Making corrections for excess of submergence and temperature, the efficiency works out at 55.5 per cent. As has been pointed out, the old air lift pump has an efficiency of about 25 per cent., and the deep well pump often goes below 50 per cent. Under these conditions Mr. Price's pump should be favorably received by the engineers of power stations throughout the United Kingdom and Ireland.—G. HAL-LIDAY, in *The Electrical Times*, London.

In A Country Engine Room.

One of the compensations for the comparative loneliness of a country location is the fact that the engine-room is the Mecca of all the engineers who visit the place,

and that the occupant thereof has consequently the chance to collect a great variety of information (with sometimes a little misinformation) from his numerous callers.

Some time ago when we were having some trouble with an air compressor which was too small for the work assigned to it, a Western visitor volunteered the following account of his experience with one of the same kind of machines:

"We had been trying for quite a while to make about a 20 horse-power compressor do 40 horse-power of work without having very good luck. Then the superintendent took the head office into his confidence, and they sent word that they had one at another place which was a good deal larger which they could spare from its present location. Perhaps though it might be too large? Oh no! the old one was 14x12x14 and the other is only 18x20x18 inches—not so *very* much larger. So, without consulting me in any way, the larger compressor was ordered loaded up and shipped to our plant. A week or two afterward it got to us and after some delay was unloaded and set up. Now, the work which it was expected to do, was to force air at 120 pounds pressure through an inch pipe, to raise water for a large mill. As 120 pounds was the limit of our steam pressure when steam was turned on, the machine ran along all right until the receiving tank was full, then stopped as suddenly as a man would if he ran against a stone wall. This was a surprise apparently to manager, superintendent and master mechanic, who had all gathered 'round to see the big machine start work. Then an effort was made to start it again, but she wouldn't budge. Then the end of the lever safety valve was lifted up with a pole and held up till the receiver was empty, and the compressor was given steam again. As before, she went off all right, but when the pressure in the receiver got up she stopped again with 'a dull thud.' It being now about 6 o'clock, further proceedings were postponed till next morning. I shall probably never get over thinking myself a big fool for my part in the next chapter in this work; for, if I had been consulted, I could have told the management beforehand what would happen. But I went home that night thinking of how a machine might be made to circumvent the laws of nature, but could think of no plan until I was eating my breakfast next

morning. Then it occurred to me that if I could fix the compressor so that only enough air could get into the compressor to keep the pipe full the machine might be able to run right along. I submitted my plan to the master mechanic when I got to the mill, but he only shook his head and said 'no good.' But I was determined to try it, so took a sheet of packing and covered the 6-inch inlet pipe with it, cutting a 2-inch hole in the center for the air to get in at. But the opening was still too large and I had to cover up a little more than half the remaining opening before the machine would run. After we found that the compressor could be made to work that way, we made a wooden cover for the inlet pipe with a 1½-inch hole in the center, to which was fitted a shutter, so that when we started up the machine a good supply of air could be let in until the receiver was full, then the air supply could be cut down, so that the compressor would keep in motion. Yes, it was a good deal of bother to look after the big old thing, because it had to be run so slow that when the steam pressure went off a little it was liable to stop, and it was quite a job to start it again. However, after the firm had spent a few hundred dollars in repairs, they discovered that they needed that machine back in its old place, and they got a new one for my mill."

Now, some people may doubt the truth of this account, and find it impossible that any man in charge of a plant would not stop to figure the probable capacity of an engine and its suitableness for his use before ordering it or allowing it to be shipped to him. Yet I have known of a manager offering a 5x7x7 air compressor for use when the pressure required in the receiver was 10 pounds above the available steam pressure.

By the way, the compressor mentioned in the beginning of this article has been supplemented by a "two-stage" compressor. Now it looks a little curious to me to see a steam cylinder of 14 inches diameter running an air cylinder of the same size and stroke, and in addition one of 8 inches in diameter, yet getting an air pressure as high as that of the steam by which it is driven.

Yet it does this right along, so we shall have to admit that it must be in accordance with natural law. One of the greatest troubles with the old compressor was the burning out of the packing of the piston rod from the extremely high

temperature of the compressed air, which at 120 pounds per square inch pressure is somewhat over 500 degrees Fahr. In the two-stage compressor, however, the partially compressed air passes through an intercooler, thus reducing the final temperature and saving all trouble about the packing.—F. RIDDELL, in *Power*.

A Large Air Compressor.

With the view of increasing the capacity of the compressed air power transmission plant which is largely used for underground haulage, the Powell Duffryn Steam Coal Company in September last placed an order with Messrs. Fraser and Chalmers Limited, of Erith, for a very large air compressor of the King-Riedler vertical type, and this machine is now ready for erection at the colliery. Its capacity is 8,300 cubic feet of free air compressed in two stages to 60 lb. pressure at 70 revolutions per minute, with 95 lbs boiler pressure, and at this speed the indicated horse power is 1,050. Probably it is the largest machine built in this country. The machine is in reality two compressors built into one machine, each side being connected to a common flywheel shaft and being readily disconnectable so that either half can run independently by uncoupling the connecting rods. The flywheel is 16 feet in diameter and weighs about 16 tons. On each side there are high and low pressure steam cylinders, and the corresponding high and low pressure air cylinders are placed above them, the high and low pressure pistons being tandem on their respective piston rods, which are connected to the flywheel shaft by the King connecting rods. This arrangement reduces the height of the machine very considerably, practically 11 feet of head room and much material being saved.

The diameters of the steam cylinders are 23 and 38 inches, and of the air cylinders 23 and 37 inches. The stroke is 48 inches. The air cylinders are water-jacketed by means of a liner forced into the barrel and caulked in place with copper rings. Hand holes in the barrels permit cleaning. Between the two stages of compression the low-pressure air from both sides flows around the pipes in a cooler placed underground. This is built of boiler plate about 4 feet in diameter and 12 feet long over all, with numerous

$\frac{3}{4}$ inch brass tubes through which water flows. One suction and one delivery valve is placed in each cylinder head of the four air cylinders, and they are closed automatically at the ends of the piston stroke through rocking valve-spindles by links worked by hardened steel cams on the wrist plates of the Corliss gear. The lift of the high-pressure valves is $1\frac{1}{4}$ inches, and of the low-pressure valves $1\frac{1}{2}$ inches. They are very light and strong considering the work they have to do, and as they have no springs and are positively closed there is a complete absence of dancing and slamming which is often so noticeable in other air valves. The advantages of the Riedler positively-closed valves both for air-compressors and for pumps is well known and generally acknowledged at the present time. The outlet valves close before the returning piston can draw back the compressed air, and the inlet valves close directly compression begins, so that the waste of cylinder space due to slow closing is reduced to a minimum. Arrangements have been made for the insertion of liners in the low-pressure cylinders, so that air-pressures up to 75 lbs. may be attained if desired at a later date.

The steam cylinders have Corliss valve gear, and are bolted together, leaving ample receiver capacity between them. The distance pieces resting on them to support the air-cylinders consist of four castings, which can be removed when the steam cylinder covers have to be lifted, for examination of the piston. There is forced lubrication for all moving parts, the oil being supplied by a separate pump on each side, and a sight-feed being placed at all the points where oil is delivered. With this arrangement all parts get their due proportion of lubricant.

A special feature of interest in this machine is the governing arrangement. One of Whitmore's patent governors is fitted on each side of the machine and are connected together when both sides are running. This governor is a combination of the centrifugal ball type with air cylinders, so that both the speed and the air pressure control the steam, but some play is allowed in the connection of the two parts, so that steam is never cut off entirely. With this device, if there is no call for compressed air, the pressure will lift the governor to such an extent that the engine will just crawl round. On the other hand, if the compressed air is drawn off very rapidly

or an air pipe breaks, the engine will not exceed its maximum speed by more than 5 per cent. To anyone who has seen an air-compressor started, the advantages are obvious, and as the speed can be reduced to about six revolutions per minute, the amount of air blown to waste is reduced to a minimum with the least waste of steam and fuel. At all intermediate speeds the supply and demand of air will keep pace with each other and the hunting of the governor is practically negligible. All the air and steam pipes are fitted with Hopkinson gate valves so that any portion can be cut off at very short notice in case of accident. At the time that our representative visited the works the machine was not running, but elsewhere in the shops a smaller single two-stage compressor of somewhat similar design was supplying compressed air, and this machine ran exceedingly smoothly and at a high speed.—*Colliery Guardian*.

A Resume of the Use of the "Baby" Air Drill at the Gold Bank Mine.*

After a good deal of persuasion the Compressed Air Machinery Company consented to make us a small drill on the same general principles of their larger or giant drill for our mine. The only specifications I gave them was that the drill should weigh about 100 pounds.

The first drill was made and delivered the last of August, 1898, the diameter of the cylinder being $2\frac{1}{4}$ inches, their larger drill in use at this mine being $3\frac{1}{8}$ inches. A thorough test could not be conveniently made during September, though it was run more or less; but the drill was given a thorough and severe test all through the month of November, with the most satisfactory results, being used principally in the stopes, though it was tried in the drifts and raises.

In the latter part of November, 1898, I ordered four more drills of the same size, advising strengthening of various parts that experience had shown were weak; received them in December, and on the first of the year 1899 I had introduced them throughout the mine to do the stopping, with the gratifying result that I could dispense with the services of sufficient miners to reduce my pay roll an average of \$1,500 a month.

*Abstract of a letter to the *Mining Reporter* from the manager of the Gold Bank Mining Company, Forbestown, Cal.

COMPRESSED AIR.

Before the introduction of the "Baby" drills all the stoping of the mine was done virtually by hand, a large drill occasionally being used in the stopes, whereas at the present time there is not a single hand driller in the mine, all the work being done by the air drills, the "Baby" drills doing all the stoping and occasionally being used to run raises; and they have been used with success in a drift where the formation was not too hard.

I am at present using a "Baby" drill to widen down the shaft, the shaft being or-

man gets in his round, and we have averaged five feet a day of two shifts.

The "Baby" drills as now made weigh about 105 pounds, and are easily handled by one man. As a rule, the miners require no help in rigging up and getting ready to run. They never need help with their drills after they have the bar in place. It frequently happens that a miner is sent from one part of the mine to another to change his place of drilling, and he shoulders his machine, takes his wrenches, etc., in his hand, and moves about without



"BABY" AIR DRILL IN GOLD BANK MINE.

iginally an upraise from a crosscut tunnel, and we are now widening down one side of it to make it large enough for shaft purposes working underhand. Most of the rock is of the hardest kind of green-stone, and there were doubts about the small drills being strong enough to stand the work, but so far we have cut down about 100 feet, without any apparent detriment to the drill. It takes a whole shift of ten hours to put in five or six holes, but each

any help from others. That illustrates the ease and facility with which the machines can be used underground.

The mine does not run but six days in the week, while the mill, forty stamps, runs seven. The mill crushes an average of 3,200 tons a month of hard quartz. I consider the quartz above the average in hardness. The stamps weigh 1,000 pounds, drop 103 a minute, discharge through a No. 7 slot-punched screen with low dis-

charge, there being no inside coppers in the mortars. Four "Baby" drills running day and night supply the mill with quartz. Of the average of 3,200 tons a month, 580 were broken by the larger machines, leaving an average of 327½ tons a month, one shift a day to the "Baby" drills.

A "Baby" drill can be used wherever a man can work single-handed. We proved that conclusively, the machines having taken the place of hand drillers, and we do not take down the hanging wall when the ledge is too small to stope without it. We have in the mine jack bars ten feet long and others only twenty inches long.

We always supply water to the miners under a pressure, running a water pipe wherever we run an air pipe. I cannot recommend such a course too urgently upon mining superintendents. The work done by the drills and the time saved by the men more than compensate for the extra expense. We used water here when we had to pump it out of the mine, and know its economy. We run our drills under an average pressure of thirty-five pounds. We use seven-eighths-inch steel for the short drills and three-quarter for the long ones. Experience has taught us that the air required to run a 3½-inch drill, under thirty-five pounds pressure, will run three and a half "Baby" drills.

I can safely recommend the use of small machines in mines, and predict a great future for them.

Air Brake "Parasites."

The consumption of air pressure generated by the pump of the air brake system for use by other devices than air brake, on locomotives and cars of the modern railroad train has become quite an important matter. Originally the full work of the air pump on the locomotive was to supply pressure for the use of the air brake system. Now it is quite different. Persons recognizing the conveniences and characteristically favorable qualities of compressed air for other purposes began using it. Its first use, aside from air brakes, was to raise water in sleeping cars from tanks underneath the floor of the car. In the early days this operation gave much trouble to the air brake system. Air was taken direct, through a non-return check valve, from the train pipe of the sleeping car to the water tanks

under the floor. Later, an improvement was made whereby the pressure was made to pass through the triple valve and auxiliary reservoir of the air brake, through a governor and non-return check valve to the water tanks. This arrangement prohibited the water-raising system from receiving its air until after the air brake system had accumulated almost its own maximum pressure of, say, about 60 lbs. This system has given very little trouble, and is in successful operation at the present time.

The use of air pressure for operating auxiliary devices on locomotives is greater than is such use on cars, and to-day we see on the modern locomotive such pneumatically operated devices as the automatic sander, traction increaser, fire-door opener, grate shaker, smoke consumer, bell ringer, water scoop and other similar devices. In the aggregate these devices consume a very considerable quantity of air, and, in fact, equally as much as, if not more than, the air brake system itself. It is, perhaps, not the actual amount of air required for the legitimate operation of these devices that demands attention, so much as it is the waste or leakage from indifferent and careless maintenance of these devices. If they and their pressure connections were carefully inspected and properly maintained the amount of air consumed would be very much smaller, and the complaints made against such devices would be much fewer.

So serious have the complaints against these devices commonly known as air brake "parasites" become, that relief of some kind has been asked for, and in some cases, demanded. An investigation into the situation and a careful consideration of means for meeting the issue has pointed out two or three ways of escape from the trouble. One is to use steam pressure on all such devices on the locomotive as will permit of it. This, however, has its objections, inasmuch that steam leakage leaves a sediment which is unsightly and unclean, and is quite different from that caused by clean air pressure. On the other hand, with the use of steam, leakage would manifest itself at the several bad joints by the forming of sediment and scale, thereby directing the attention of the inspector to the leakage, when the repairs could be easily and quickly made. On such devices as the sander, the use of steam would, of course,

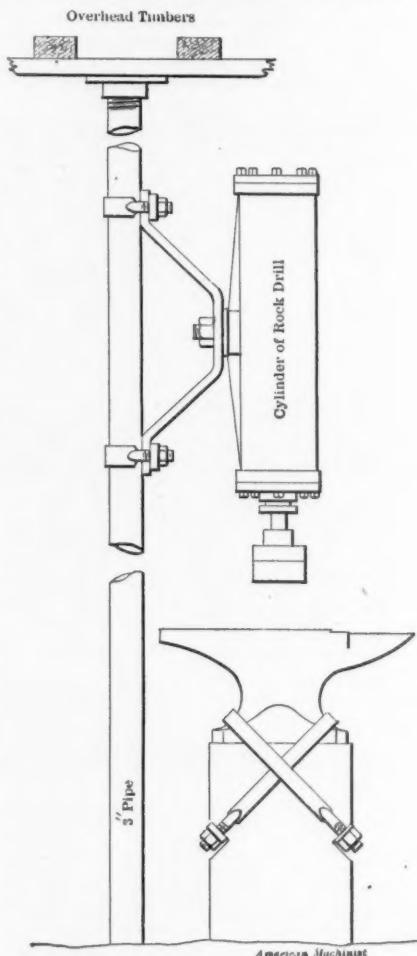
be impossible. The other devices, however, or a large number of them, at least, would do as well with steam for their operation as they do with air.

Another means of overcoming the difficulty mentioned would be to supply engines with a second air pump, whose duty would be to deliver pressure to a reservoir separate from the air brake system, and thus independently supply the "parasites." Still another means would be to use a larger pump than is now used on engines, pumping into the main reservoir of the air brake system, then reducing out of that to a second and separate reservoir for the "parasites." This would be similar to the arrangement of the water-raising system on sleeping cars. The first mentioned remedy would undoubtedly be preferable, inasmuch that the "parasites" would be independent of, and isolated from, the air brake system, which it could not interfere with as it does at the present time. Possibly an attachment might be made to send the over-supply of the "parasite" reservoir to the main reservoir of the air brake system, thus aiding and assisting the air brake system, instead of interfering with it and taking from it, as at the present time.

The seriousness of the situation seems to be sufficient to warrant some such scheme for relief. Even at the present time, with the above named devices or "parasites" in operation the air pump is frequently overtaxed in supplying the train pipe leakage of the train, leaving very little pressure to be diverted for the use of the "parasites." In the future we may expect to see additional pneumatically operated devices such as reversing gear, throttle opener, whistle operator, oil distributor and smoke consumer for the locomotive, and window hoists, seat turners and ventilating fans, etc., for the coaches, to say nothing of possible coupling and buffering devices operated by compressed air. With the experience of the past, the conditions of the present and the possibilities of the future, some disposal of this extra work on the air brake pump should be made, else complications will surely arise, and, at a critical moment, may seriously interfere with the operation of that great safety device, the air brake, ending possibly in disaster.—*American Machinist*.

A Rock Drill as a Blacksmith's Hammer.

A correspondent writes the *American Machinist* as follows: "While visiting the Elkton Mine at Cripple Creek, Col., last summer, I was interested in the ingenious way in which a rock drill had been rigged up to take the place of



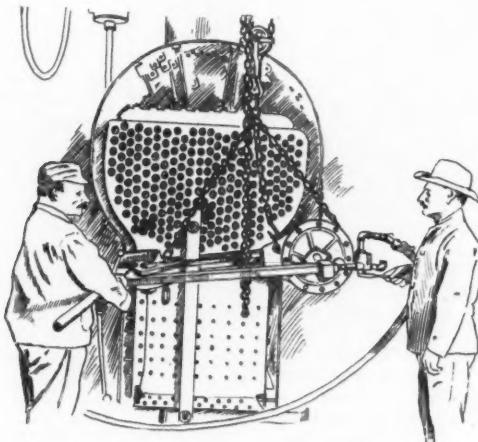
A ROCK DRILL ARRANGED AS A STEAM HAMMER.

one or two blacksmith helpers in the blacksmith's shop. The drill, minus the tripod, was fastened to a vertical support.

An ordinary anvil was fixed in a position under the ram, and the necessary air connections were made with the cylinder. When a blacksmith has some heavy hammering to do, he has some one, as usual, to manage this contrivance, while the smith takes care to have the blows struck in the proper place, as with a steam hammer, except that the blows are not as heavy, but a sight more numerous for a given space of time. At the time that I saw this improvised (?) steam hammer in operation the blacksmith was working down a piece of steel or wrought iron, about three inches wide at its widest part, one inch thick at its thickest part, $2\frac{1}{2}$ feet long, tapering in both width and thickness, and the hammer appeared

ing illustration and made by the Baird Portable Machine Co., Topeka, Kan. Designed to cut out old fire-boxes, it can be operated by one man, with a boy assistant to handle the valves, and is capable of cutting out the largest size fire-box in ten hours. It is claimed that an average saving of \$18 a day can be made by the use of one of these staybolt breakers. In using the tool, the makers consider the more economical way is first to separate the fire-box from the forward part of the boiler; although if it is desired to remove the fire-box by taking out the door sheet and back head, no difficulty will be experienced in operating the machine. It weighs but 800 lbs.

The staybolt cutter, an illustration of



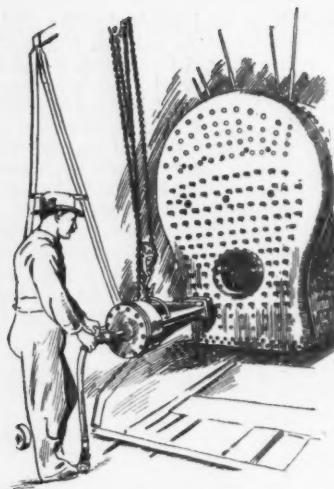
BAIRD STAYBOLT BREAKER.

to be doing excellent service. It appeared to me to be a very simple, effective and quite inexpensive apparatus, especially considering the fact that it, excepting the hammer head, was rigged up from material to be found in any mining outfit, and that it could be very easily resolved into its original parts and their former duties resumed, since neither drill nor anvil suffers any from this somewhat unusual use."

Pneumatic Staybolt Appliances.

A simple device, yet a labor-saver, is the staybolt breaker shown in the accompany-

which is also shown, was designed for cutting off the ends of staybolts after they have been screwed into place in the fire-box. The machine is a cylinder and frame combined, the cylinder diameter being 15 in., and may be operated either by steam or compressed air, preferably the latter. With a working pressure of 100 lbs. it will cut off staybolts up to $1\frac{1}{8}$ in. in diameter, at the rate of 1,200 per hour, and at a proper distance from the sheet to allow for heading over. Use of this tool prevents loosening the bolts in the plates, as frequently occurs where a hammer and chisel are used. The weight of the appliance is 450 lbs, and one man can handle it. A



BAIRD STAYBOLT CUTTER.

larger machine, the No. 2, is similar in design, and will cut off bolts up to $1\frac{1}{4}$ in. diameter.—*Railroad Gazette*.

Pneumatic Tube Service in Modern Factories.

A saving appliance, which has for its attainment an increase in the efficiency of the several departments in a manufacturing establishment, by cutting down to a minimum the necessary time consumed in issuing orders, and such additional information that may be necessary for their prompt and proper execution, such as notices, changes, drawings, etc., should receive most careful consideration, and if found to possess those merits peculiar to all successful devices, should be promptly adopted and installed.

Many different systems of department communication are in use to-day, each one of which doubtlessly possesses more or less merit, and while all may be properly classed as efficient factors, very few can demonstrate their right to a perfect title of sufficiency.

While speaking-tubes and telephones may be extensively used and are a satisfactory means for verbal communication (where conditions are favorable), still

they must necessarily have additional assistance that the present growing demand of shop requirements, such as the quick and safe delivery of written orders, drawings, etc., may be met.

An efficient telephone service in conjunction with a pneumatic tube system is probably the best equipment the market has to offer the manufacturer, in which all the requirements are satisfactorily met, though the pneumatic tube system could of itself be made to serve both purposes.

The Dodge Manufacturing Company, at their main office and works (Mishawaka, Ind.), have recently added to their very complete telephone service an extensive pneumatic tube system, known as the Miles Pneumatic Tube System of New York, and speak in the most eulogistic terms of its efficiency.

The central station is located in their present telephone booth which in itself is situated in their main office, both being in charge of the same attendant.

The system comprises thirteen sets of tubes leading to and from the central station, in connection with which an auxiliary station is situated at foundry office, from which all matter directed to warehouse and isolated departments can be transferred.

Departments handled exclusively from the central station are, draughting room, advertising department, machine shop office, foundry office, wood shop office, shipping department, stock keeper's office; balance of tubes leading to the several departments of main office.

The tubes in this system are two and one-half inches in diameter, and all bends are of sufficient radius to allow for free transmission of cartridges eighteen inches long.

The compressed air for this system is carried in separate pipes, and therefore air is only used when transmitting the cartridges.

It is obvious that under such a system orders, written instructions, etc., can be promptly and safely transmitted to and from the different departments.

The many uses of a pneumatic tube system can't be thoroughly appreciated until one has seen it in actual service, when its manifold uses pronounce it as being pre-eminently the most prompt and greatest labor saving device in use.—*Power and Transmission*.

A Pneumatic Water Supply System.

The problem of water supply is often very serious in buildings which are isolated and have not the facilities for connecting with a general water-distributing system such as is provided for a town or city. Those who are thus situated will be interested to hear of the recent invention of Mr. Edward D. Deeter, of Milford, Ind. The invention provides a peculiarly constructed pump, adapted for elevating water from a well, and forcing it into a sealed tank against the air confined therein, so that the pressure of the air will force the water from the tank into a system of water pipes for the supply of one or more buildings. The construction of the pump is such that it will pump air with the water into the receiving tank, thus maintaining a suitable pressure for the service pipes. The construction further permits adjustment of the mechanism or the exact graduation of the amount of air pumped, or an arrest of the air-pumping operation, as may be found necessary. The pump is situated at the top of the lift pipe, from which water is forced through a pipe at right angles thereto, and is conducted into the tank. A clack-valve covers the top of the lift pipe and prevents regurgitation of the water lifted into the cylinder. A hollow plunger-rod extends into the cylinder and is provided at its lower end with a cup-shaped packing-ring, which engages the inner side-wall of the cylinder, and a disk valve which, on upward motion of the plunger, is adapted to close the openings in the base-plate of the plunger-head. The lower end of the hollow plunger-rod is closed by a plug which serves to hold the base-plate in position. The central passage extending through this block is closed by a valve under spring tension. The stem of this valve extends upward and is engaged near the top by a tappet-lever hinged to and passing through the wall of the hollow plunger-rod. An upright post secured to the upper end of the cylinder is provided with an opening at its upper end which affords a bearing for the plunger-rod.

The operation of the main plunger is similar to that of the ordinary pump. On the upward stroke water is drawn past the clack-valve into the main cylinder, and on the downward stroke it is forced past the disk-valve into that portion of the

cylinder above the plunger head. On the next succeeding stroke the water is forced into the receiving tank. An ordinary check-valve prevents a return flow of the water. As previously stated the pump is designed to supply air pressure to the tank so that the water may be forced to the upper story of a high building. The air is fed into the pump in the following manner: When the plunger-rod is traveling upward, at a predetermined point the outer end of the tappet-lever mentioned above encounters a spring-limb secured to the guide-post, and is thereby thrown down, its inner end lifting the valve from its seat in the plunger-rod plug. The lever is secured in this position by a pair of spring clamping-arms situated directly below, and is thus held until released by a V-shaped pressure-block at the top of the guide-post, which spreads the springer-arms apart. Air is thus admitted to the cylinder at each stroke, in quantities which can be regulated by the position of the spring-limb on the guide-rod, and from the cylinder the air is pumped with the water into the receiving tank. To stop the pumping of air it is necessary merely to raise the spring-limb to its highest position, where it cannot engage the tappet-lever.

Though the pump, as stated above, is designed for use in furnishing a water supply for buildings not connected with the general water-supply system, it will readily be seen that the invention would be useful in connection with a general water supply for the elevation of the water to a greater height than could be otherwise reached. The pump will also be found useful.—*Scientific American.*

A Novel Air Compressor.

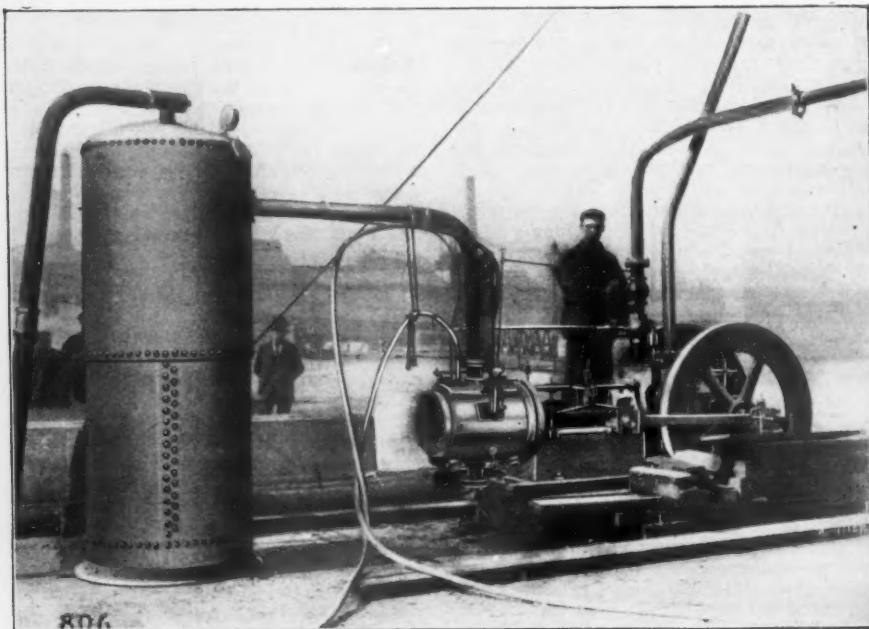
An interesting air compressor, containing no piston nor any moving part save valves, has recently been described in the "Revue Universelle des Mines et de la Metallurgie." It is due to Mr. Emile Gobbe, and has been tried with some success at the Monceau Company's blast furnace. The arrangement consists of an explosion chamber, the outlet of which leads to a chimney. A throttle valve which tends to remain open by its own weight is introduced between the chimney and the explosion chamber. Two conduits, one for gas and the other for air, lead to this chamber. At some distance from the

points at which they enter the combustion chamber each conduit is provided with an inlet and an outlet valve, the latter communicating respectively with the receivers for compressed air and compressed gas. A draught having in any suitable way been started up the chimney of the plant, charges of air and gas are drawn in and mix in the combustion chamber. The mixture is then fired by an electric spark. The explosion closes the valve to the chimney, and forces a portion of the air and gas back along their respective conduit pipes and through the discharge valves into their receivers. When the pressure falls sufficiently, the valve at the base of the chimney opens automatically again, and a fresh charge is drawn in and the action repeated as before. In the experimental plant erected at Monceau, the explosions followed each other at the rate of twelve to fourteen per minute; but the plant proved to be in need of considerable modifications if satisfactory working was to be obtained. In a laboratory apparatus since constructed and designed to work with town in place of blast-furnace gas, good results have been obtained in the

matter of regularity of working, and the inventor claims that with a large plant carefully designed very considerable economy could be relied on, and the capital cost would be extremely small.—*Science and Art of Mining*, London.

American Compressor in Scotch Shipyard.

We show here an example of how extremely careful American manufacturers should be with instructions which they send out with machinery for foreign customers. The picture illustrates a small size steam actuated air compressor and a vertical receiver of American manufacture, sent to a Scotch shipyard and installed temporarily, as shown in the picture. Although careful instructions accompanied the machine as to the method of placing the oiling devices, the picture shows that they put the sight-feed steam-cylinder lubricator on the air cylinder and air-cylinder lubricator on the steam cylinder. The illustration also shows the method of making turns in pipes which finds general use in England and on the Continent.



AMERICAN AIR COMPRESSOR IN SCOTCH SHIPYARD.

Compressed Air Car in Severe Service.

We are all more or less familiar with the good record made by the compressed air cars used in the all-night service on the Clark street line of the Chicago Union Traction Co. The illustration herewith shows the results which can be obtained with compressed air even under most adverse conditions, the car being at work in deep snow.

its later designs of street car motors have the running parts made heavier than in the earlier types.—*Street Railway Review*.

Compressed Air Mine Hoists.

Compressed air is used for hoisting, both inside of the mine and on the surface. Either steam or compressed air is preferable to other media for hoisting, and the majority of hoists are built to use either



FIG. 1.—COMPRESSED AIR CAR WITH SNOW PLOW.

The advantages offered by an independent motor for car service under exceptional conditions are well known and it is also appreciated that there are various applications for air as an auxiliary in many cases where the overhead trolley is the most economical and desirable for regular service. The mechanism of an air motor being similar to that of the steam engine is quite as reliable and has the same range of speed and power.

The Compressed Air Co., of New York, has extended its field of operations and is preparing to build mining locomotives;

one or the other medium, and the fact that they can be used in the same hoist proves an advantage in many places.

For underground work most of the hoists are small and are operated on winzes. Except in particularly favorable places, these hoists are operated with cold air, and are, therefore, not economical, as far as power is concerned; but they are extremely useful.

A winze hoist should be backed up by a large receiver near by.

Compressed air timber hoists are an extremely useful appurtenance for under-

ground work. They are light, weighing five or six hundred pounds, have small reels and small geared engines, and are of powers ranging from 5 to 10 h.p. For hoisting timbers and drills into an uprise, or for hoisting timbers into shops or around a mine generally, they are very useful. These hoists are also made on trucks so that they may be taken from one part of the mine to another very easily. All these underground hoists consume from 20 to 25 cubic feet of free air per horse-power of actual work done.

Surface hoists operated by compressed air are much in vogue, especially where the power is electrically transmitted to the mine. A portion of the electrical power is converted into compressed air to be used for the hoists. The most economical way to use this air is to so arrange the plant that the electrical power is practically constant and the compressor is just large enough to absorb the power. There must be large storage capacity, so that when the hoist is not in operation the power may be stored.

The hoist itself should be a compound first-motion hoist to be a thoroughly up-to-date machine. A compound geared hoist is not quite so economical in air. The hoist cylinders should be jacketed. The air, after passing from the receivers, should go through a heater having two compartments, one for high-pressure and one for low-pressure air. In the first compartment the air is heated to about 400 degrees and passes around the jackets of the initial cylinder and finally into the cylinder itself being exhausted from there back to the second compartment of the heater, where it is heated again to about 400 degrees, passes to the low-pressure cylinder of the hoist, and from there escapes to the atmosphere. A hoist of this character requires from 7 to 8 cubic feet of free air per horse-power, a vast difference as compared with the requirements of a cold air hoist. The cost of reheating is very small.

—*Engineer and Iron Trade Review*, London.

The New York Rapid Transit Tunnel.

An interesting publication entitled "New York Rapid Transit Tunnel" has recently been issued by the Rand Drill Company of New York. Turning over its pages we are impressed by the beauty and practical value of the illustrations and by the clearness of type and the admir-

able plan by which the reader gets a clear and comprehensive view of the subject treated. Beginning with a brief history of underground tunneling in New York and describing the work of the Rapid Transit Tunnel as it is at the present time, the publication ends with a brief statement of the "future of rapid transit," in which attention is called to inevitable extensions of this system, and "thus New York City," it is said, "is likely to see an era of tunnel building in its endeavor to keep up with the great growth of the five boroughs of the city." The general construction of the work is shown by sections and plans and the route of the tunnel is outlined. Special attention is called to the use of compressed air as the power for driving the machinery. This large and important piece of work is really an object lesson to contractors in the use of compressed air for excavation. It is known, of course, that the Rapid Transit Tunnel is not altogether a tunnel, but a succession of subways and tunnels; in fact, the word subway applies more properly to the case. Even in open work compressed air is used and has been found to give better results, not only because of the freedom from steam and smoke in the streets, but because the power may be transmitted some miles from the generating station with safety and economy. This work is equipped with air compressing plants from the City Hall to Harlem, and the use of air has here been proved to be of great practical value.

Vaporization Experiments.

The experiment of freezing water by its own evaporation is more often described than performed, as it succeeds only with an unusually good air pump. A similar experiment with melted camphor is less impressive in one way, for the temperature required to freeze the camphor is not very low, but the experiment is far more showy, can be exhibited to a greater number at once, and is very easy to perform. A very slight diminution of pressure brings the boiling point below the freezing point, so that if a flask or test tube of melted camphor be connected to an air pump, and but one or two strokes taken, the liquid will boil under the reduced pressure, and almost immediately flash into a bulky, porous, solid mass, puffed up by the vapor that was coming off during the act of solidification.

By heating the camphor under diminished and varying pressure it is easy to change at will from sublimation to distillation. If a cold rod is thrust down a test tube in which the camphor is boiling, the cooler vapor in the upper part of the tube condenses on the rod in sparkling crystals, like frost, while lower down the hotter vapor is condensing to liquid. In fact, camphor may be made to illustrate, not only the appearance, but the true cause of formation of frost, snow, etc., while in its pleasant odor, it has an advantage over many substances used in experiments of this kind.—W. P. WHITE, University of Wisconsin.

"Pneumatic Chipping Hammer."

The accompanying half-tone illustrates a somewhat novel application of the ordinary pneumatic chipping hammer in a quarry in England. It will be noticed that the man in the foreground is trimming the edge of a piece of flagging, using the ordinary pneumatic chipping hammer just as would be done in the case of a piece of steel. By means of this tool the work of trimming up the stone is done far more rapidly and quite as satisfactorily as could be done by hand.



A NOVEL APPLICATION OF THE PNEUMATIC HAMMER.

Ingersoll-Sergeant Drill in Hawaiian Islands.

Our illustration here shows a new use for the rock drill and has a double interest from the fact that the picture was taken in the Hawaiian Islands.

The drill in question is an old Ingersoll-Sergeant machine and is one of the four built for the Hawaiian Government.

As shown, it is mounted on a wagon and is being hauled by an Ohio Road Roller, which also furnishes the steam for operating the drill. The combination formed one of the features in a Fourth of July parade.

The incident is simply another illustration of how rapidly our new possessions are becoming Americanized and calls attention once more to the fact that after all there is some truth in the statement that "Trade Follows the Flag."



INGERSOLL-SERGEANT DRILL IN HAWAIIAN ISLANDS.

Notes.

It is stated that the Philadelphia Pneumatic Tool Co. will increase its capital stock to about \$2,000,000 in order to take care of its rapidly growing business and to prosecute extensions of it into all parts of the world.

Women civil engineers may figure later in the profession. In any event, three women have signified their intention of taking the civil engineering course at Cornell University for next year. They are the first to take the Cornell course.

The American Air Compressor Company's Danish representative at Copenhagen, has just published a pamphlet describing the American Air Lift Pumping system with reference to their air compressors and governors. It also contains cuts and matter pertaining to the direct acting air compressor manufactured by the Union Steam Pump Co.

The contracts for the new plant of the Cleveland Pneumatic Tool Company have been awarded to Messrs. J. A. Reaugh & Son, of Cleveland, Ohio. It is expected to have the plant completed and ready for operation within ninety (90) days. The plant will be equipped with the most modern machinery and appliances for turning out the largest amount in the shortest time.

The W. J. Clark Company, of Salem, O., who make the "Quick-as-Wink" couplers for compressed air hose, are very busy with orders for that new style of couplers. They are said to be much more convenient for use than the old style couplers and as connections can be made or broken in about one-tenth of the time required when common couplers are used, the new style of couplers work a saving of time in shops where air hose is used.

It is reported from Chicago that John Condon, the blind race track owner and turfman, is recovering his eyesight, through the treatment of Dr. Gary, a Baltimore specialist. Condon said to-day that objects only dimly visible before commencing the treatment could now be plainly distinguished.

He has tried many European specialists

in vain. The treatment is by a new apparatus, in which compressed air and electricity are used.

The Librarian of Congress, Washington, D. C., writes that they are short of several numbers, which they are very anxious to have in order to complete the file of COMPRESSED AIR for the Congressional Library. If any of our readers can furnish any of these numbers, a list of which we give below, it will be very much appreciated:

Volume 1. Nos. 5, 6, 7, 8, 9, 10, 12.

Volume 2. Nos. 1, 2, 3, 5, 6, 7, 8.

Volume 3. Nos. 2, 3, 4.

Ash hoists are used in many forms for raising ashes from the ash-pits. Compressed air is generally used to raise buckets from the pits. The ash-pit is supplied with a number of clam-shell buckets, resting in cradles, with wheels to run on the pit rails beneath the engines. The hoist dumps these buckets into a car on the adjacent tracks. One large road is preparing to install an electric traveling crane over its ash-pits, believing that this will be the most satisfactory device which can be used for this purpose.

A large grain elevator has recently been put into service by the Iron Elevator & Transfer Co., of Buffalo, N. Y. This is made entirely of concrete and steel, and is situated on the Lake Shore & Michigan Southern. Compressed air is distributed to all points of the elevator. This air, at a pressure of 100 lbs. per sq. in., is used for blowing dust out of the motors, for sweeping floors and beams, and for syphoning any water that may collect in the drain pits under the elevator. A blacksmith's forge is also supplied with air from this system.

Bids were recently opened by the acting postmaster general for the rental of pneumatic tube service in Boston, New York, Brooklyn, Philadelphia, Washington, Chicago, and St. Louis, several of the bidders or their representatives being present. The bids greatly exceed the appropriation of \$500,000 granted by congress to be used for the purpose for the fiscal year 1903 and it was announced that no awards would be made at present, as it will be necessary to make some adjustment among the different cities in order to come within the appropriation.

Among the accessories at the power plant of the Berkshire Street R. R. Co., Pittsfield, Mass., is a system of compressed air pipes with five outlets distributed about the engine room, arranged for $\frac{3}{4}$ -inch hose connections for cleaning purposes. The air is furnished at 70 pounds pressure by a Westinghouse compressor connected with a receiver. A system of lubricating oil pipes has also been installed, including an oil purifier, oil reservoirs, etc. The oil is distributed by air pressure furnished by the air pump above mentioned, the oil tanks being placed in the engine room basement.

It is sometimes the case that gas engines have air inlets too small and compression spaces too large for satisfactory work in a rarified atmosphere. When a gas engine is intended for high altitudes it should have a larger air inlet and a smaller compression space than when the same engine is to work at sea-level. For altitudes of more than five thousand feet the engine should have a plate attached either to the piston or to the cylinder head, in order to reduce the compression space. Gasoline at high altitudes evaporates at a much lower temperature than at the sea level, and it is well, therefore, to use the heavier grades at high altitudes.

The compressed air plant in connection with the Westinghouse electrical equipment of the C. & C. Shaft of the Consolidated California & Virginia Mining Co., at Virginia City, Nevada, supplies the air for drilling a number of underground hoists and the hydraulic pump. This plant consists of a $16\frac{1}{2}$ in. x 30 in. Rand & Waring single stage air compressor, driven at 73 R.P.M. by a 100 H.P., type "C" Westinghouse motor. The motor speed is 580 R.P.M., which is reduced by a counter shaft with wooden rim pulleys and rubber belting. No automatic regulator is used at the present time, as the compressor is working to its full capacity and the motor is developing 96 H.P.

The water used to drive the water wheel in a water power air compressor can be used afterwards to cool the air compressed. It is good and economical practice to cool the air before it enters the compressor, to cool it again while being compressed, to give it a third cooling

between the compressors, where a two or three-stage compression is made, and finally to cool it after it leaves the last compressor. Each cooling saves power employed in making compression. If the same water used for power is used for cooling the cost of cooling is only interest and repairs on the cooling plant. After the air leaves the receiver and before it is used, the quantity of heat that has been taken from it put back into it again adds to its effective working value.

Nearly all mechanics and engineers who use compressed air for the transmission of power imagine that the using of it for such purposes is something new, but that is not correct. To be sure, its use for mechanical purposes has been greatly developed since George Westinghouse used it for transmitting power to brakes, but it is more than one hundred years ago since William Murdoch, so closely associated with James Watt, transmitted power through the engine works at Soho, near Birmingham. He drove the machinery of several shops by air compressed by the blowing engine, and he built a lift which also was operated by compressed air. Among the other purposes to which Murdoch applied compressed air was the transmission of packages through tubes. He was really the inventor of the pneumatic air tube transmission which has been used so successfully of late years.

One of our correspondents living in Cincinnati, Ohio, writes us that the outside of the Grand Opera House in that city, has just been cleaned by the application of the compressed air sand blast, and that the contractors have been heavy losers. Each night when an inventory has been made it would be found according to our correspondent's story, that they were minus tons of sand, supposed to have found its way into the open mouths of the wondering spectators.

A man standing on the scaffold suspended from the eaves high above the passing crowds operated a hose, through which the compressed air passed. The air was filled with fine sand which was driven with great force against the stones, which were crusted over with coal soot. The impact removed the sooty surface revealing the original color of the stone. The sand was very fine, and the operator wore a canvas mask to prevent the particles

from entering his throat, eyes, nose and mouth.

At the Fore River Shipyard, Quincy, Mass., electricity and compressed air are used throughout. Those responsible for the equipment of the works possessed one advantage of the greatest importance. All of the appliances, no matter of what description, and no matter of what value relatively, were to be new. There was absolutely no old and antiquated machinery for which space had to be provided. All the buildings came under the same category, as the ground was free of all incumbrance. These circumstances gave the designers a perfectly free rein and permitted them to construct and equip unhampered by any pre-existing conditions. The result is a shipyard admirably arranged for the quick and convenient handling of all material. The power house is centrally located, as far as various buildings are concerned. In this building are two air compressors of the Rand & Ingersoll-Sergeant types, which supply all the pneumatic tools. Air is distributed through the works at a pressure of 100 pounds.

The exhibition of ship riveting which the Chicago Pneumatic Tool Company are making in Glasgow, Scotland, is proving highly successful. The work there is in charge of Mr. E. Guennell, for many years superintendent of the Chicago Shipbuilding Company at South Chicago, Illinois, and he reports most favorable progress and great interest on the part of the shipbuilders on the Clyde. To further assist him in his work, the Chicago Pneumatic Tool Company have sent two expert riveters from the Chicago Ship Yards to Glasgow. The Chicago Pneumatic Tool Company are injecting American methods into their European business, and have recently sent Mr. F. D. Johnson, manager of their New York office, to push business there, and have also sent Mr. George H. Hayes to take charge of the mechanical work in their London works.

Mr. W. H. Armstrong, from the headquarters of the Chicago Pneumatic Tool Company, at Chicago, will have charge of the New York Office of that Company.

There is a valve setting machine in operation at the shops of the Cleveland, Lorain & Wheeling R. R., at Lorain, O.,

by means of which it is said two men can set the valves of a locomotive in four hours, including the moving of the eccentric blade, etc. The machine is turned under the driving wheels by means of a No. 1 Little Giant air motor, through the gearing of an old-style cylinder boring bar, the ratio of which is $17\frac{1}{2}$ to 1. The rollers supporting the main driving wheels are made of cast iron 6 ins. in diameter, with faces 2 ins. wide, the latter and the shafts turning together, the rollers being keyed to the shafts by gib-end keys. The key-ways are made $\frac{1}{2}$ in. longer than the keys to permit of lateral movement, which is necessary to prevent the rollers breaking or chipping off. Two sprocket wheels and driving chains are utilized for conveying motion to the back pair of rollers from the motor-driven shaft. An especially advantageous feature of the driving mechanism is a slow motion device to be operated by hand when near the end of the valve travel. A left-handed ratchet attachment is placed opposite the air motor, and when the main drivers are nearing the centre the air is shut off and the ratchet mechanism employed to move the wheels to the exact centre.

The water supply for general cooling in the factory and refrigerating apparatus at the Power Plant of the Central Lard Co., Jersey City, is obtained by means of the air lift from three driven wells on the premises, the wells being located in the corners of a triangle, the shortest distance between any two being about 75 feet. One well is 500 feet deep and two 300 feet, and all are 8 inches in diameter to rock and 7 inches through rock. The air lift apparatus was furnished by the Pneumatic Engineering Company, of New York, and consists of two steam-driven, central crank and double flywheel, Rand Drill Company air compressors automatically regulated to maintain the desired pressure in two air reservoirs in the engine room. One compressor is operated ordinarily to compress to 20 pounds for factory purposes, and the other, drawing from the 20-pound pressure reservoir to compress to 110 pounds for the air lift. The air reservoirs are 3 feet in diameter and $8\frac{1}{2}$ feet high. The water is delivered into two tanks in the factory basement and pumped therefrom by a 300-gallon double-acting Stilwell-Bierce & Smith-Vaile

triplex pump. In connection with this system are three storage tanks on the fourth floor, and the water can be pumped to these for a gravity supply to the factory.

Sanding Plants.—Where the demand for sand is large, as on roads with a concentration of a large number of engines in a small territory, it seems advisable to install central sand drying outfits and distribute the dry sand in box cars.

At Middletown, N. Y., the New York, Ontario & Western has a sandhouse of brick 25 x 46 ft. in size. Sand is received in gondola cars and shoveled through one of the windows. From the dryer it falls into a hopper and passes into a sand reservoir, from which it is elevated by compressed air into the dry storage for delivery to the engine on the tracks outside of the building. Other tracks may be reached from the storage bin if desired.

At Collingwood, on the Lake Shore, sand is received over the coal-chute trestle, at the end of which it is dropped from the car into a storage bin. It is shoveled into a steam dryer and falls into either of two sunken reservoirs. From these it is elevated through straight vertical pipes into the dry storage above, and is ready for the engines. On applying air pressure to the sunken reservoirs, the air first passes through a vertical cylinder. It raises the piston of the cylinder and closes the entrance from the dryer by means of a large rubber ball. When this ball-valve is closed the piston is high enough to uncover the opening to the pipe which admits the air to the reservoir and elevates the sand.

The Internal Combustion Engines, which work by passing air through a fire and thus expanding the volume at constant pressure, imposes on the fire some conditions which must not be left unsatisfied.

Air must be compressed into the firebox, and at each delivery of the compressor there will be a pressure increase on the fire; similarly at each admission to the engine cylinder there will be a pressure drop, and while we may call the system a constant pressure combustion system, this cannot be strictly true. What is constant is the mean pressure, and even this may vary after a limited

time, for variation of admission and cut-off will change it. So that a fire to work successfully in this apparatus must be unaffected by pressure variation whatever may be its extent or suddenness.

One of the greatest advantages that may be derived from this type of engine over the explosive, for example, is the possibility of employing the cheap and safe heavy oils. But to realize this advantage we must add to our conditions one imposing the requirement that heavy oils shall be burnt. And finally, the products of combustion must be delivered at a constant temperature, and that as high as possible. Moreover, this maximum must be known to the designer who proportions his cylinders and mechanism for some particular volume expansion dependent on this maximum.

It has been reported from Binghamton, N. Y., that John Reap is under arrest for killing Elmer Cook, a fellow-workman, by means of compressed air. Reap is a New York machinist, working in the Ontario and Western car shops at Norwich.

In the shop is a powerful pump for compressing air, which is capable of raising the pressure to a high degree. The men about the factory have been accustomed to turning a small current of the air on their clothing to dust them off. The air is conveyed from the tank through a hose furnished with a nozzle similar to a garden hose.

Elmer Cook, on finishing his day's labor, took the nozzle to dust off his clothes. The air was turned on slightly and a small jet was blowing the dust from his clothing when Reap appeared. It is said ill feeling had existed between the men. Reap tried to seize the nozzle for his use and Cook objected. Reap snatched the nozzle from Cook and placing it against Cook's body, turned on the full force of the compressed air.

It hurled Cook across the room and he became violently ill, dying in a short time. An autopsy showed that the air had ruptured the intestines in such a manner as to cause hemorrhages and acute inflammation and thus cause death. Recorder Hyde issued a warrant for Reap's arrest.

He was arraigned in Court and entered a plea of not guilty.

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz.: all communications should be written on one side of the paper only; they should be short and to the point.

St. Louis, Mo., Aug. 27, 1902.
COMPRESSED AIR, 26 Cortlandt St., N. Y.

Gentlemen: We note in your July issue, page 1915, that F. J. Matchette, proprietor of the St. Charles Hotel, Milwaukee, was the first hotel in the world to install a permanent plant for cleaning by compressed air. This is an error, as this company had installed compressed air plants and cleaned hotels with compressed air and operated in the St. Charles Hotel, Milwaukee, two years prior to this alleged permanent plant. The plant in the St. Charles Hotel is not a permanent plant, and we have a suit pending in the Federal Court against F. J. Matchette's Company for infringement of our patents. We would, therefore, thank you to make a correction of this statement in your next issue.

We are sending you enclosed our illustrated catalog. Yours very truly,

GENERAL COMPRESSED AIR HOUSE CLEANING COMPANY.

J. S. Thurman, V. P. and G. M.

**U. S. PATENTS GRANTED JUNE
AND JULY, 1902.**

Specially prepared for COMPRESSED AIR.

703,127. ELEVATOR. Melanthon Hanford, Malden, Mass. Filed Aug. 20, 1901. Serial No. 73,743. *

In combination with an elevator car, air cylinders secured in the upper part of the wellway, free elastically-moving pistons in said air-cylinders, suspended depending safety-ropes attached to said free moving pistons, a clutching device secured to the car for the purpose of grasping the elastically-suspended safety-ropes; an endless rope attached to the clutching device which travels with the car and revolves a speed-governor, the said governor, a brake-wheel, stop-pins in brake-wheel, a brake-wheel friction-band and hooks connected to

the brake-wheel band, said brake-wheel friction-band operated by the governor for the purpose of throwing the clutches into action by arresting the movement of the traveling endless rope; all arranged substantially as shown and for the purposes set forth.

703,356. DRY ORE-CONCENTRATOR. Robert E. Waugh and Eugene Waugh, Denver, Col. Filed May 27, 1901. Serial No. 62,153.

In a dry-ore-concentrator, the combination with a suitable stationary frame, of a vibratory apron-frame constructed to form an air chamber, an endless traveling apron through which the air from the chamber passes, the apron closing said chamber at the top, an auxiliary air chamber arranged in suitable proximity to the main air chamber, means for introducing air under pressure to the auxiliary chamber, and means for vibrating the apron frame.

703,385. PAINTING APPARATUS. Henry D. Carryl, New York, N. Y., assignor to James R. Hay, Nutley, N. J. Filed Aug. 9, 1901. Serial No. 71,433.

In a portable apparatus for painting or cleansing surfaces, the combination of a chamber and a suitable base or stand, a supplemental chamber connected therewith, a receptacle for containing the painting or cleansing material, a pump connected with the principal chamber and arranged to be connected with the receptacle for introducing the material into the chamber in convenient quantities, an independent air-compressor connected with said supplemental chamber by a suitable pipe for causing the air in the chamber to be compressed and the material to flow automatically therefrom, a portable hand-tool arranged to paint or cleanse, a flexible conducting-hose connecting the chamber with the tool, whereby the painting or cleansing material can be introduced into the tool, and a valve in the handle of the tool for controlling the supply of the material to it through the hose.

703,400. FOG-HORN. Ernest A. Gill, Gloucester, Mass. Filed May 24, 1901. Serial No. 61,818.

A fog-horn made up of a casing; a bellows; means to operate said bellows; an air-compressor below said bellows; a horn above

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said casing; a reed; and an air-conduit connecting the horn with the air-compressor.

703,419. MEANS FOR DRIVING SHUTTLES OF LOOMS. John Houston, Sunderland, England. Filed Oct. 12, 1900. Serial No. 32,876.

In looms and other textile machinery, a cylinder piston and piston-rod attached to the desired part of the machine and adapted to be operated by compressed air, said piston-rod having a projection for throwing the shuttle, a valve controlling the admission of compressed air to the cylinder aforesaid, a valve-rod carrying said valve and having a roller or wheel attached thereto, a cam carried by an intermediate rod and engaging with the roller or wheel aforesaid, a pivoted lever engaging with the end of said intermediate rod, a projection carried by one of a train of gear-wheels driven from the main shaft and adapted to periodically engage with and operate the pivoted lever aforesaid, substantially as described and for the purpose set forth.

703,480. AIR-BRAKE MECHANISM. William H. Sauvage, Denver, Colo., assignor, by direct and mesne assignments, to the Sauvage Duplex Air Brake Company, Denver, Colo. Filed Feb. 8, 1901. Serial No. 46,573.

703,611. ATOMIZING APPARATUS. John Robertson, Cincinnati, Ohio. Filed Apr. 11, 1898. Serial No. 677,191.

703,637. PNEUMATIC SIGNALING APPARATUS. Joseph H. Brady, Kansas City, Mo. Filed Dec. 26, 1901. Serial No. 87,342.

A pneumatic signaling apparatus comprising an air-storage receiver, separate outgoing distributing-pipes for the compressed air, a detonating fluid signaling device connected with one of said pipes, and a fluid-cylinder upon the end of the other outgoing pipe, a piston and a piston-rod and coating with the detonating fluid signaling device, and a combined back-pressure relief and cut-off valve in the pipe leading to the cylinder, and a spring extending around the piston-rod, within said cylinder and bearing upon the opposite side of the piston subject to the pressure of the fluid.

703,732. STEAM AND AIR FEEDING APPARATUS FOR BOILER-FURNACES. James Marshall, Dunfermline, Scotland. Filed Dec. 21, 1901. Serial No. 86,813.

703,758. PNEUMATIC RIVETING-TOOL. John W. Birkenstock and Richard W. Funk, New York, N. Y., assignors to the Empire Pneumatic Tool Company, New York, N. Y., a Corporation of New York. Filed Dec. 14, 1901. Serial No. 85,911.

The combination, with a casing provided with supply channels and ports, of a handle at one end of the same, a tool guided in the opposite end of the casing, a piston-valve located at the interior of the casing, said piston-valve being hollow and provided with circumferential grooves and an opening in one of said grooves, a return-channel connecting the rear end of the casing with the front end of the same, a sliding hammer in the casing, a cushioning-spring located between the piston-valve and handle, a channel connecting the interior of the casing with the space behind the valve, and shoulders at the rear end of the casing for arresting the spring and the piston-valve in their forward motion, substantially as set forth.

703,855. AIR-VALVE ATTACHMENT FOR TRAPS. Charles A. Tilly, Brooklyn, N. Y. Filed Apr. 2, 1901. Serial No. 54,038.

703,886. AIR AND VACUUM VALVE. Everett P. Allen, Chicago, Ill., assignor, by direct mesne assignment, to R. M. Wilbur, Chicago, Ill. Filed Mar. 25, 1901. Serial No. 52,703.

703,983. BOOT OR HOUSING FOR PNEUMATIC ELEVATORS. Chester Bradford, Indianapolis, Ind. Filed Nov. 19, 1900. Serial No. 37,061.

704,059. HYDRAULIC AIR-COMPRESSOR. William J. Linton Woodstock, Canada, assignor to the Taylor Hydraulic Air Compressing Company, Limited, Montreal, Canada, a Corporation of Canada. Filed Feb. 21, 1900. Serial No. 6,044.

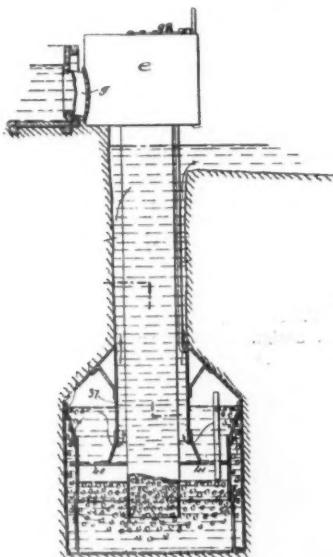
In a hydraulic air-compressor, a pair of subchambers located one above the other, a vertical water-conduit communicating at its lower end with the lower subchamber; a water-passage leading from said lower to

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said upper subchambers; a water-conduit leading from the upper subchamber to the

opening communicating between said funnel and the air cushion, and an air-valve in said opening.



overflow of the compressor; an air-pipe leading from the lower to the upper subchamber and air-pipe leading from the upper subchamber to the point of consumption.

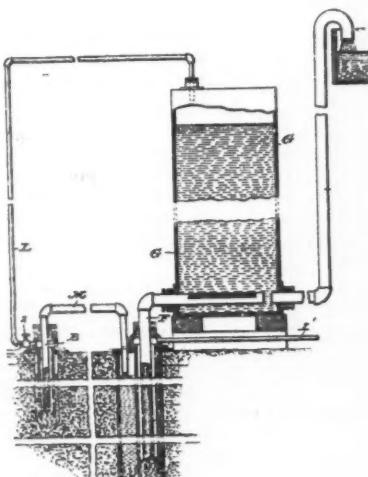
704,098. PNEUMATIC LASTING-MACHINE. Chas. K. Pickles, St. Louis, Mo., assignor to himself, Louis Bry, St. Louis, Mo., and Ike Block, Memphis, Tenn. Filed May 18, 1901. Serial No. 60,844.

704,360. BLOWER AND COMPRESSOR. Christian Neumann, St. Louis, Mo., assignor to the Natural Power Co., St. Louis, Mo. Filed July 3, 1901. Serial No. 66,960.

704,509. AUTOMATICALLY-INFLATED POLISHING-WHEEL. Isaac P. Cadman, Beloit, Wis. Filed Nov. 11, 1901. Serial No. 81,875.

A pneumatic polishing-wheel having an air-cushioned polishing-surface, a funnel for catching air as the wheel is rotated, an

704,608. APPARATUS FOR RAISING WATER. George R. Young, Ridgewood, N. J., and Clifford Shaw, New York, N. Y., assignors to the Bacon Air Lift Company, a Corporation of New Jersey. Filed Nov. 23, 1898. Serial No. 697,263.



In combination in a water-raising system, an air-lift well, an uptake therefor, means for aerating the column of water in the uptake to raise it, a separating vessel or tank to which the uptake delivers, a pipe for delivering water from the separating vessel or tank to a higher level without aeration, and means for discharging the air from the separating vessel or tank while maintaining the requisite pressure within the tank, the said separating vessel or tank being of such considerable height vertically as to act as a regulator or compensator as distinguished from a mere separating vessel or tank of height incapable of effecting such regulation or compensation, substantially as set forth.

704,694. SYSTEM OF DISTRIBUTION. John L. Creveling, New York, N. Y. Filed Sept. 11, 1901. Serial No. 75,015

COMPRESSED AIR.

In a system of distribution for railway-trains the combination of a generator and current-utilizing devices and pneumatic device for affording delivery of current to the current-utilizing devices always in the same direction, the said pneumatic devices being actuated by a change in the direction of the pressure in a pneumatic system on the train.

704,737. AIR-BRAKE APPARATUS. Edward P. Donnelly, Boston, Mass. Filed Mar. 5, 1902. Serial No. 96,766.

704,782. AIR-PRESSURE REGULATOR. Joseph H. Dickinson, Detroit, Mich. Filed June 25, 1901. Serial No. 65,946.

An air-pressure regulator comprising a collapsible bellows having an elongated exhaust-port, a valve pivoted at one end adjacent to said port and a connection between the opposite end of said valve and the movable wall of the bellows adapted to cause the gradual closing of said port by the collapsing of the bellows.

704,912. PNEUMATIC IMPACT-TOOL. Samuel Oldham, Philadelphia, Pa. Filed Nov. 4, 1901. Serial No. 80,969.

In a pneumatic impact-tool, a cylinder, a piston or hammer adapted to reciprocate in said cylinder, a housing adapted to close said cylinder at one end thereof, a chamber arranged in said housing transversely to said cylinder, a valve adapted to reciprocate in the chamber of said housing, means adapted to conduct live air or fluid to the interior of said valve and means controlled by the movement of the piston for admitting live air or fluid to the valve-chamber in rear of said valve substantially as and for the purposes described.

705,310. PNEUMATIC CONVEYER. John W. Siefert, Waco, Tex., assignor of one-half to Louise Elkel, Waco, Tex. Filed July 6, 1901. Serial No. 67,290.

705,407. PNEUMATIC STACKER. Edward Huber and Jacob W. Miller, Marion, Ohio. Filed Apr. 12, 1902. Serial No. 102,620.

705,415. AIR-BRAKE ATTACHMENT. Thomas C. Manson, Lake Charles, La., assignor of two-thirds to Charles Smith and Archie Pierce Sale, Lake Charles, La. Filed Feb. 19, 1901. Serial No. 47,061.

705,436. AIR-TOOL. Nino Pecoraro, Spezia, Italy. Filed Aug. 24, 1901. Serial No. 73,181.

In a pneumatic tool, a cylinder, a piston therein, shoulders upon the extremities of said piston, a valve movable on said piston, between said shoulders and provided with ports extending therethrough, inlet-ports in said cylinder, an inlet-passage in said piston leading upwardly therethrough, an inlet-passage therein leading downwardly therethrough, an exhaust-passage in said piston extending to the end thereof and having the ports and an inlet-passage in said piston for enabling said valve to be operated.

705,515. JOINT FOR USE IN PNEUMATIC APPARATUS. Chas. L. Davis, Chicago, Ill., assignor, by direct and mesne assignments, to Engelina Heuer, William H. Heuer, and A. Miller Belfield, Chicago, Ill. Filed Apr. 30, 1900. Serial No. 14,976.

In a pneumatic apparatus, the combination of a metallic pipe having its end provided with a laterally-projecting lip or flange, a support or holder for said pipe, the said support or holder being composed of wood, and the pipe or tube being fitted into the same, so that the lip or flange overlaps the surface of the wood, and a member having a port or passage adapted to form a continuation of the bore of the said pipe or tube, the said member being fitted against the wooden support or holder for the pipe or tube, so that the port or passage in the member registers with the bore of the pipe or tube and also so that the rim of said port or passage abuts against the lip or flange which overlaps the surface of the support or holder, and which thus lies and fits closely between the abutting surfaces of said support and said member, substantially as set forth.

705,585. PNEUMATIC DUST COLLECTOR AND SWEEPER. Jno. T. Hope, Kansas City, Mo. Filed July 20, 1901. Serial No. 69,001.

A pneumatic dust-collector comprising a vehicle, a motor, a suction and blast apparatus upon said vehicle, actuated by said motor, a transversely-extended air-suction and vacuum-forming dust-receiver having a longitudinal opening upon its under side

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for the entrance of the dust and movable upon the surface of the ground, conductors for the dust connected with said receiver and also connected with the induction-opening to the said suction and blast apparatus having swivel-joints, and aprons hinged to the said receivers, means for vibrating the receiver laterally in position on the side of the vehicle and elevating devices connected with said hinged aprons and adapted to raise and lower said aprons alternately.

705,592. AIR-BRAKE SYSTEM. William G. MacLaughlin, Windsor, Canada, assignor to the MacLaughlin Railway Brake Company, Detroit, Mich., a Corporation of Michigan. Filed May 11, 1901. Serial No. 59,741.

705,757. PNEUMATIC TRACK-SANDER. Edward M. Hedley, Depew, N. Y. Filed Mar. 19, 1902. Serial No. 98,884.

705,830. PNEUMATIC MOTOR FOR CAR FANS AND VENTILATORS. Clarence A. Evans, Upland, Pa. Filed Nov. 24, 1900. Serial No. 37,585.

705,884. INLET FOR PNEUMATIC- DISPATCH TUBES. Fred R. Taisey, Indianapolis, Ind., assignor to the Taisey Pneumatic Service Company, Indianapolis, Ind., a Corporation of Indiana. Filed Oct. 14, 1901. Serial No. 78,558.

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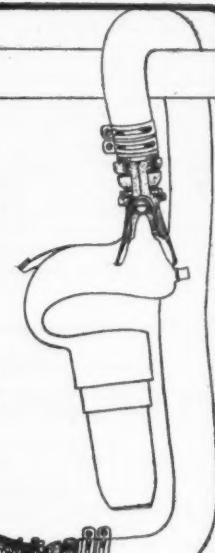
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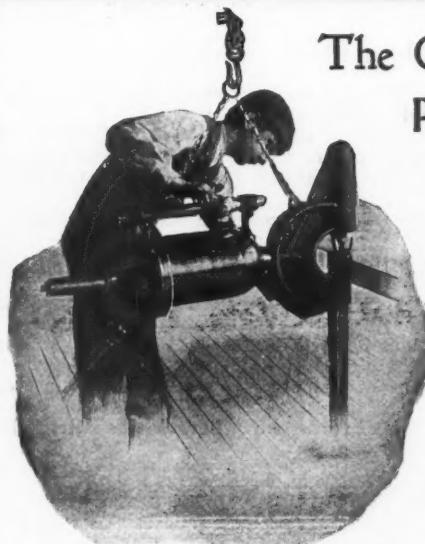


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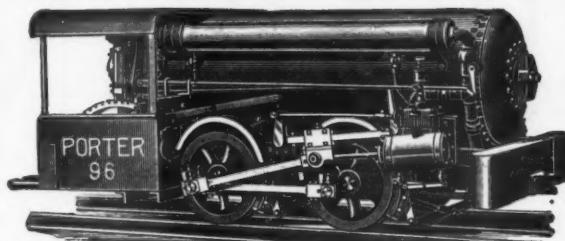
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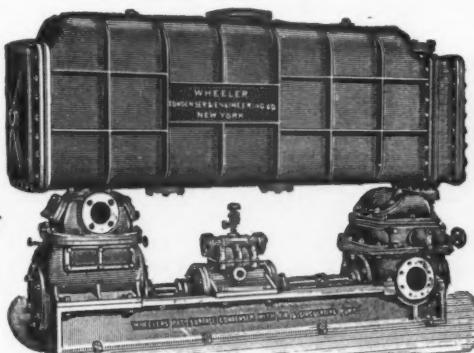
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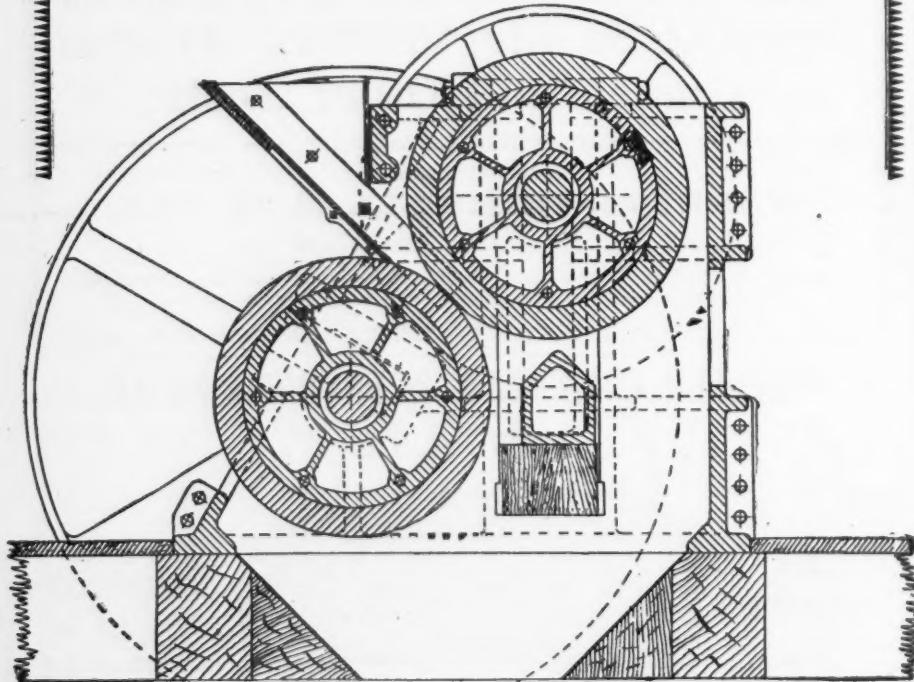
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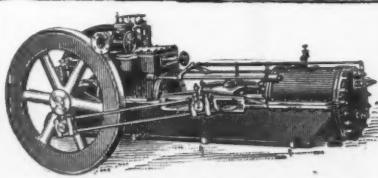
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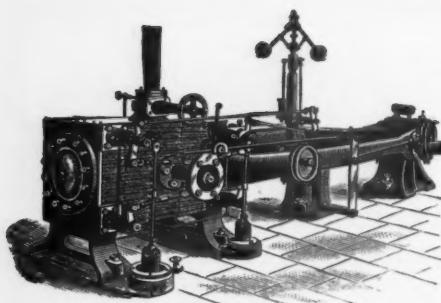
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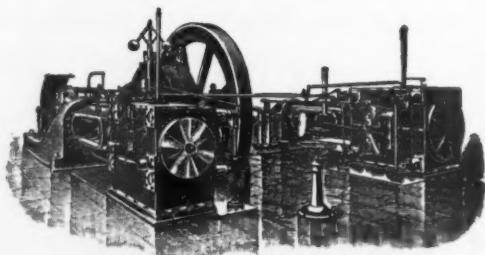
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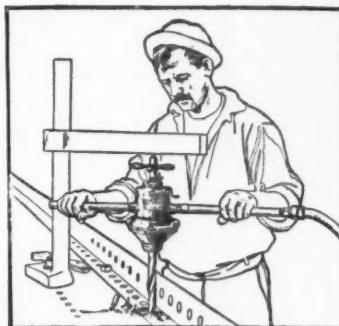
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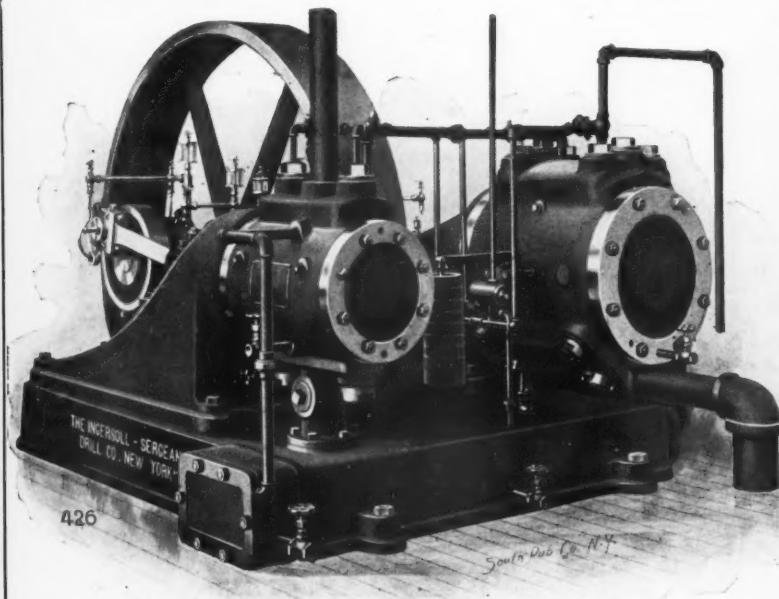




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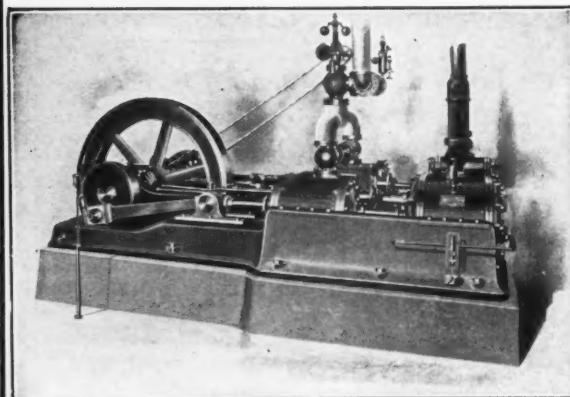
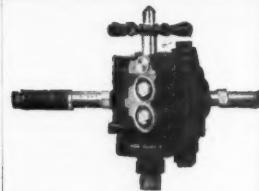
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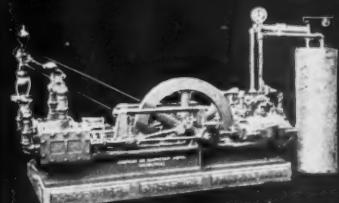
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